U. M

MARINE ENGINEERING.

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LOSS OF THE PACIFIC MAIL STEAMSHIP CITY OF RIO DE JANEIRO.

The sinking of the steamship *City of Rio de Janeiro* at the entrance of the bay of San Francisco on the morning of February 22 last, which resulted in the loss of two millions in property and 131 lives, has been prolific of investigations. The wreck of the vessel is one of the strangest marine disasters of the age. One of the most peculiar features of the aftermath of the terrible happening is the great difficulty in determining just where the ship went down and who was responsible for her loss.

PACIFIC MAIL LINE S.S. CITY OF RIO DE JANEIRO, LOST FEBRUARY 22, 1901, IN SAN FRANCISCO BAY.

Three different State and Federal commissions have been struggling with the testimony and, at present writing, one of these, the State Pilot Commission, is receiving evidence tending to bring to a focus all the testimony pro and con in the matter of responsibility of the pilot, Fred'k Jordan, who was on the bridge when the *Rio de Janeiro* struck an unknown rock. The evidence advanced in this inquiry, however, is merely a repetition of that secured by the U. S. Local Inspectors of Hulls and Boilers, Messrs. Bolles and Bulger, acting for the United States. The U. S. Life Saving Service also held an inquiry with a view to determining whether the lookout at Fort Point had heard the *Rio de Janeiro's* signals of distress. It may be said in this connection, for the purpose of settling

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a dispute that has been variously misrepresented in the daily press, that the man Ellingsen, who was on lookout duty, under oath denied the statement made by his superior officer, Captain Hodgson, that he had confessed to hearing the danger signal blown by the vessel and had not paid any attention to it. Ellingsen, with a frankness that seemed to carry weight of truth with it, testified that he had never made a confession and that he had not heard the steamer's whistle. He did not try to get out of town and came forward voluntarily to offer his testimony. It was a case of one man's word against another's and the reader is left to pass judgment for himself. The Life Saving Service findings have been sent to Washington and may not be made public for some time.

The Federal investigation, conducted by Captains Bolles and Bulger, was called on the afternoon of February 28. The first witness was First Officer Graham Coghlan, a relative of Captain Coghlan, U. S. N. He was followed by Chief Engineer Herlihy. These two witnesses were important from the standpoint of marine engineering, as it was Coghlan who said that he carried the orders from the pilot to the chief engineer, also the captain to the chief engineer. He said that he could not find Mr. Herlihy and that he in consequence delivered his orders to First Assistant Engineer Brady, who executed them.

Mr. Coghlan testified, in answer to Captain Bolles' questions, that it was 4.30 o'clock in the morning when the steamer commenced to heave short on the anchor. Captain Jordan went to Captain Ward's cabin and asked him if he wanted to proceed in. Captain Ward said he thought it was safe to do so and as the vessel got under way, he came on deck. Witness went below for a few minutes and when he came on deck again the ship was making half speed and the course was continued until Point Bonita light was seen. He denied that the lead had been used. This important point in the testimony has been overlooked by most publications. Witness said that the fog closed down and a few minutes later the vessel struck. The whistles were sounded and witness tied down one of the cords himself. He then took his position near his boat and tried to get the passengers and crew into the craft. He was positive that the whistles were blowing a continuous blast until the steam was exhausted.

"Did you see the engineer or any of his assistants on deck after the ship struck?" asked Captain Bulger.

"No, sir, I did not," was the reply.

"In your opinion where did the vessel strike?"

"On the starboard side of the keel, well forward."

Chief Engineer Herlihy was then called and stated that he had been a chief engineer since 1873 and had never met with any serious marine accidents. He then said:

"Captain Ward gave orders Thursday night that we should move until the fog cleared. The sea watches were then set among the engineers. When we anchored we had 145 lb. of steam up. The limit was 160 lb."

At this juncture a dispute arose between the witness and Captain Bulger. Captain Bolles asked Mr. Herlihy if he had not made a verbal statement to Captain Bulger to the effect that there was not steam enough up when the vessel started for port.

"I never made any such statement," said Engineer Herlihy.

Captain Bulger: "Well, you made that statement to me and I am very sorry that I did not take it down in writing."

Asked if he thought his place was in the cabin when the vessel was started for port, the witness said that he was not called.

"But you were called?" commented Captain Bulger.

(A) "I was not called."

(Q) "Didn't Coghlan call you?"

(A) "No, he did not."

Captain Coghlan, who sat at the right of witness, said that he had called the chief through the medium of First Assistant Brady.

"I am sworn to tell the truth and I am doing it," replied the chief engineer.

Mr. Herlihy then made a statement in which he explained that he got out of his room as soon as the vessel struck and proceeded to the engine room. He remained there until the water drove him out.

(Q) "Why did you not go on watch when the vessel started?"

(A) "I did not think it was necessary."

(Q) "What are your duties as engineer?"

(A) "My assistants were competent men."

(Q) "How do you know that the steam was at 145 lb.?"

(A) "It was never lower. It may have been 150 or 155 lb."

(Q) "Well, in other words, you don't know?"

(No answer.)

(Q) "Was the full engine room crew on watch?"

(A) "Yes."

(Q) "Did you see them?"

(A) "No."

Captain Bulger: "Then you don't know?"

Chief Herlihy: "I had full confidence in my assistant, Mr. Brady."

(Q) "What I want to know is whether the vessel had steam enough to carry her through the strong tide that was running. Can you tell that?"

(A) "I believe she had."

(Q) "But you don't know; you were in bed?"

Witness said that he did not think that the vessel had struck when he felt the jar. He heard no noise or confusion on deck, and was under the belief for several minutes after the accident occurred that there was no danger.

The question was repeated, "Did any one call you?" and the answer was, "No, sir, and I think that explains the great loss of life."

Mr. Herlihy was not called to the stand again until March 4, and in the meantime the testimony taken by the U. S. Inspectors was confined to members of the deck crew, and was a repetition of the stories told of the loss of the steamer and comparatively unimportant, except to show that the tide was somewhat too strong and the fog too thick to have brought a ship into port in absolute safety.

The heavy discharge of the Sacramento and San Joaquin rivers during seasons of long rains causes an unusual current to set from San Pablo bay, direct through Raccoon straits and about Alcatraz island into the main channel. This current is erratic and dan-

gerous to breast in a fog, as its exact speed, never known, is governed by the volume of river discharge. The supposition arrived at was that an inset swung the steamer toward Fort Point, between Mile Rock and the Fort Point reef, and it is still an open question whether the ship grounded on the reef and slipped back into deep water, or struck an unknown rock somewhere between the points indicated. The bulk of opinion still clings to Fort Point reef as the place of striking, as a number of witnesses told of seeing a red light at a sharp angle overhead. Fort Point light is the only red light at the south entrance to the harbor.

Chief Engineer Herlihy was recalled to the stand by Captain Bulger, and offered an explanation of the rules of the Pacific Mail Steamship Company governing engineers. These rules appear to be explicit in ordering all of the engine room crew to be on the working platform when a ship is entering port. Chief Herlihy was forced to admit that he was not on the platform, and it was alleged that the rules in this respect are frequently violated by engineers who place great confidence in their assistants.

(Q) "When the vessel struck did you order the men to get out of the engine room?"

(A) "I ordered them out of the engine room, but not to leave the ship."

(Q "You did not order them to their boats?"

(A) "No, sir; if I had heard two whistles I would have ordered them to the boats."

(Q) "Are you sure no signal was given?"

(A) "I did not hear it, and if it had sounded I think I would have heard it."

(Q) "Why didn't you keep the men at the pumps?"

(A) "The pumps were not working."

(Q) "Well, if the pumps were not working, why didn't you order them out and to their boats?"

(A) "I did not think that the vessel was sinking or in any immediate danger."

(Q) "If your men were on deck don't you think because they were not Chinese more lives would have been saved?"

(A) "Well, I don't know about that. I saw men on the deck whose lives were not saved. I don't think that anybody thought that lives would be lost."

Charles Englehardt was called to give testimony regarding the engine room crew. Witness was the ship's freight clerk. He said that the danger signal was blowing just before the vessel went down. It was about ten minutes from the time the ship struck until she sunk.

By Captain Bulger: "Did the men of the engine force have any chance to save their lives?"

(A) "I cannot say as to that."

(Q) "If they were not between decks would they not have had as good a show to save themselves as you who were on deck?"

(A) "Yes, sir."

On March 5 a number of unimportant witnesses gave

SAN FRANCISCO BAY—SPOT WHERE VESSEL IS SUPPOSED TO HAVE FOUNDERED MARKED WITH A CROSS.

testimony in support of that already given concerning the fog and lights. Mate Graham Coglan was recalled, and the course of the ship when under way was secured through him.

He said: "The vessel was steering northeast, small eighth east. This course was held until 5.19 a. m. Then it was changed northeast half a point. This was followed immediately by northeast by north. This was followed by starboard half a point, then starboard hard and the vessel struck."

(Q) "Was the vessel sheering?"

(A) "She was not; she kept a good course."

Pilot Jordan was called and substantiated Coghlan's testimony. He added that Ward left his side when the ship grounded and rushed about trying to get the passengers into boats.

On March 7 Mate Coghlan again testified that the engineer's crew was not on deck when the vessel struck, and Pilot Jordan rounded off the technical testimony by giving the bearings of the Cliff house, at the extreme point of south entrance to the harbor, as east one-half south, when the vessel lay at anchor before starting for the inner bay. Asked if he knew how many boats were launched, he said that he did not think that more than two were floated, but he saw the crew working at three others that were on the chocks or swung to the falls. When the signal was given the engine room to go ahead he could see one mile. That was the reason he did not think it dangerous to go in.

The final testimony in the Federal investigation was taken on March 8, and the only witness called was John K. Carpenter, who was a passenger on the steamer.

"I met Captain Ward," said the witness, "a few minutes after the ship struck. He did not seem to be excited. I did not notice any of the engine room crew. I asked the Captain if he thought anything very serious had happened, and he replied, 'Well, it is safest for you to get your belongings together. We may have to leave the ship.' It was foggy and everything was dark. Mrs. Rounsevelle Wildman was on deck and did not seem to realize the danger. She was complaining about her baby not having any shoes on and she wanted the nurse to go and get them. The nurse refused."

The stewardess also refused, and witness urged Mrs. Wildman to get into a boat. She walked away and that was the last he saw of her.

The witness got a life preserver and the strap broke. He tried on another. Third Mate Holland was in one of the boats and witness managed to reach the craft. Holland shouted to witness, "Is that you, Jack?" Witness replied in the affirmative. Holland then asked him to take the tiller, and the officer stood at the bow urging people to come over the side. The ship lurched and commenced to go down, and a loosened spar fell and struck one of the Chinese sailors in Holland's boat and killed him. The boat was capsized. Witness heard Holland shout, "Good-by, Jack, I cannot keep up."

When asked whether the ship's whistle was blowing, witness replied that in his belief it was blowing almost continuously, and when the ship was sinking it was blowing long blasts.

The inquiry then adjourned.

The *City of Rio de Janeiro* was an iron steamship of these dimensions: Length, 344 ft.; beam, 38 ft.; depth, 28 ft. 9 in.; gross tonnage, 3,548 tons; net tonnage, 2,275 tons. She was fitted with triple expansion engines, with cylinders 28 in., 44 in., 70 in. by 48 in. and six Scotch boilers, each 12 ft. 7 in. dia. and 11 ft. 6 in. long. She was barkentine rigged and had one stack, as shown in the accompanying photograph of the vessel, taken when she was in the Government service recently as a transport.

She was a three decked steamer, with saloon deck and houses, and had seven bulkheads. She was built at the Roach yard, Chester, Pa., in the year 1878 by the late John Roach, who at that time contemplated the establishment of a line of steamers from United States to South American ports. She was a well built vessel for her type and time and in the many years of her service had been subjected to many severe storms. She was one of the fleet of the Pacific Mail.

The *City of Rio de Janeiro* left Hong Kong on her last voyage January with a valuable cargo of silks, tea and other commodities and a large sum in specie. On her way she stopped at Nagasaki and Honolulu and arrived off the harbor of San Francisco on the night of February 21. Among her passengers were Rounsevelle Wildman, U. S. Consul General at Hong Kong, who was returning home on a visit accompanied by his wife and two children, with their nurse. None of these was saved. Very few bodies of those who were drowned have been recovered, as in most cases they have been probably swept out to sea by the strong current.

Report of S.S. Ventura Inquiry.

The inquiry by the U. S. Inspectors at San Francisco into the mishap of the S.S. *Ventura* has been concluded. In our last issue we published a report of the evidence given by the principal witnesses, and at that time, as we stated, the inspectors had adjourned the inquiry to determine whether they had power to take the testimony of outside experts. It was found, however, that the legal powers of the inspectors to take testimony were confined to the licensed officers of the steamship. It will be recalled that the mishap was caused by the bursting of the port main steam pipe in the trunkway between the engine room and the boiler room, while the vessel was on her way from the builders' yard, Cramps, at Philadelphia, to her home port, San Francisco, where she will join her sister ships in the Spreckles Line. The *Ventura* is a twin screw vessel fitted with triple expansion engines and single ended boilers of the Scotch type working under Howden's system of forced draft.

The explosion caused the immediate death of five men and injuries to five others, who subsequently recovered. The killed were: George W. Robb, junior engineer; William Farren and J. Desmonda, firemen; Paul Beier, coal passer; and Felix Glass, stowaway.

These boilers are connected to the engines by two lines of main steam pipes made of copper 3-8 in. thick and 10 3-4 in. inside diameter. Starting through a tunnel way from the engine room bulkhead, to which the first lengths are flanged, and joining the flanges of the stop valves in the engine room, they form a watertight bulkhead. Each line is in three lengths in the tunnel trunkway, which is about in the center of the ship.

and of 12 ft., 10 ft. and 6 ft., respectively, one of the port and the other on the starboard side, connecting at the end of the trunkway with a copper elbow, having an inner radius of 22 in., and extending 9 ft. athwartships, from the center of the elbow, one to the port and the other to the starboard side, where each is flanged to a cast steel elbow (forming part of the main steam pipe) with brackets cast on the back in the shape of T's and bolted to the after fire room bulkhead. A neck is cast on the bottom of each of these elbows, one leading to the copper pipe, attached to the stop valve on the after port boiler and the other to the stop valve on the after starboard boiler. These pipes then continue forward above the boilers in lengths of 13 ft. 6 in. each, and connect with cast steel chests 20 in. long forming the body of the expansion joints and having brass glands and stuffing boxes. Flanged to this casting is another 27 in. long, having a cast neck on each which leads to the copper pipes attached to the stop valve, one on the forward port boiler and the other on the forward starboard boiler in the after fire room. The main steam pipes then extend forward a distance of 13 ft. 6 in. to the middle fire room bulkhead to which they are flanged.

The local inspectors, in reaching a decision, reviewed the testimony of the several witnesses at the investigation. Mr. McGinn, "builders' engineer" for the Cramps, who made the trip on the vessel, had testified that a 5 in. copper pipe between the heaters gave out from defective brazing and that the rupture of the main steam pipe "was caused by water hammering due to excessive priming of the boilers, which weakened the pipe."

The testimony of all of the licensed officers showed that the boilers lifted water on the voyage several times prior to the accident, and to such an extent as to retard the speed of the engines, and cause them to be stopped and the cylinders drained. The steam pressure at the time of the accident was 165 lb.

Chief Engineer Haines, and First Assistant Engineer Lawrence (the licensed engineer in charge of the watch at the time of the accident) had examined the pipe after the explosion, testified that in their opinion it had been weakened by being burned during the brazing.

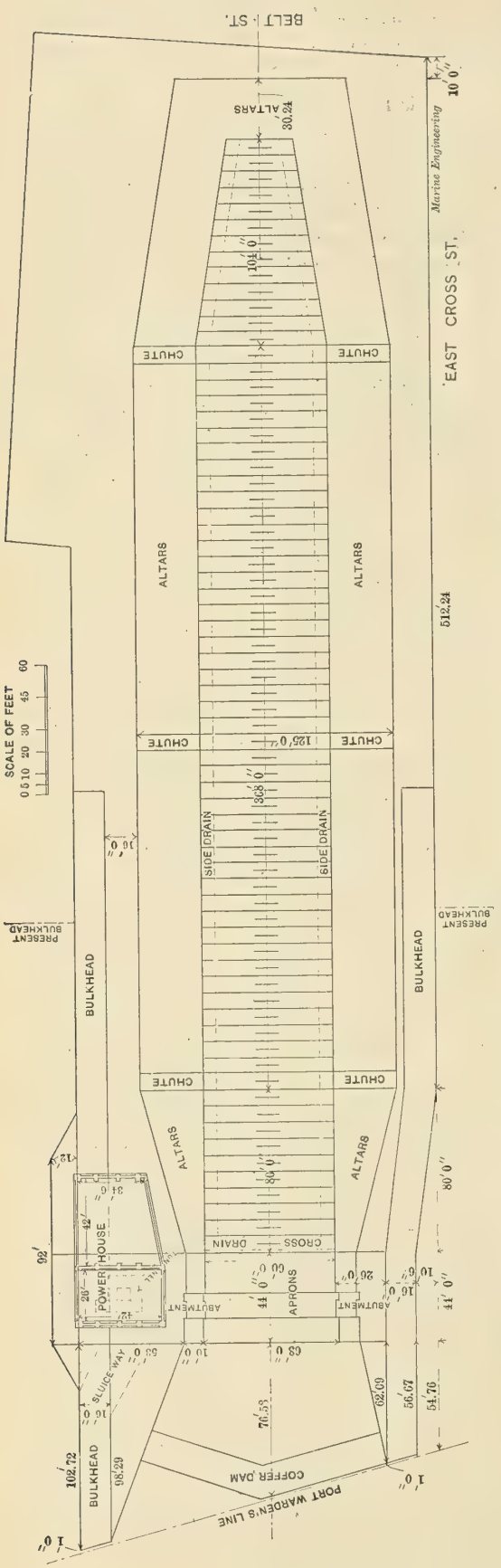
In the judgment of the inspectors, Mr. McGinn's testimony on the cause of the explosion was contradicted by the facts disclosed in the evidence that the starboard steam pipe withstood the same pressure at the same time as did the port one, the condition of both pipes being identical as to thickness, diameters, lengths and flanges.

The exploded pipes had been critically examined by the inspectors, who found the rupture had taken place horizontally along the edge of the outer brazed lap for a distance of about 5 ft. The center of the fracture opened about 14 in. The edge of the outer lap appeared to have been "unduly hammered" into the copper beside it, producing a scoring or indentation as was frequently noticeable, in former times, in the laps of boilers which were caulked with sharp caulking tools. The inference was that the scoring or indentations together with the indications of the pipe having been burned along the outside line of brazing were responsible for the accident. In conclusion they decided that from the testimony given at the hearings it was clear that no blame attached to any of the licensed officers of the steamship, as the accident was beyond their control.

Loss of Navy Vessels.

In the House on February 21, Mr. Hepburn stated that he was unwilling to intrust the officers of our Navy with the administration of criminal justice in the Navy, because of the fact that about twenty-five of our vessels had been destroyed or run on reefs or rocks or coast, and in no instance had there been adequate punishment. The severest punishment, and the only one of its kind, was where one of the officers had been dismissed the service. "Others had been for a time retired temporarily, one, I think, for three years on pay, and that was reduced, if my memory serves me, by the action of the Navy Department to nineteen months." In reply Mr. Dayton showed that of nineteen vessels named by him as having been lost, the *Narcissus*, the *Fredonia*, the *Wateree*, the *Trenton*, the *Vandalia*, and the *Yosemite*, went down under the force of earthquake, storm and cyclone that no human power could resist; two others, the *Suwanee* and the *Saranac*, in northern waters, on account of uncharted dangers; one other, the *Rogers*, frozen in the Arctic seas, by accidental fire; two more, the *Oneida* and the *Tallapoosa*, were the victims of other vessels' negligence in collision; another, the *Charleston*, struck the hidden rock unmarked on the inaccurate Spanish chart, the only one that could be afforded to her to navigate by, and another, the *Saginaw*, was carried on a reef by an unknown current. Punishment in these thirteen cases of loss would have been out of question, and if it had been attempted enlightened American sentiment would have denounced the attempt as cruel and inhuman. The *Maine* was lost under circumstances which emphasized the high character of her officers. The commanding officer of the *Ashuelot* was dismissed the service for the loss of his vessel. The commanding officers of the *San Jacinto, Galena, Alliance, Constellation,* were tried, found guilty of neglect and sentenced to suspension. The commanding officers of the *Triana* and *Brooklyn* were tried and acquitted with the approval of the Secretary. The accidents to *Enterprise, Nipsic, Monongahela* and *De Soto* were so clearly unavoidable that no courts were ordered. The injury to them was occasioned by the fog and uncharted dangers. This is thirty accidents accounted for altogether of the twenty-five referred to by Mr. Hepburn.—*Army and Navy Journal*, N. Y.

S.S. Korea.—The Pacific Mail Steamship *Korea* was launched at the yard of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., on March 23 last. She was christened by the daughter of the president of the Pacific Mail Steamship Co., Miss Tweed.. The *Korea* is of these dimensions: Length over all, 572 ft. 4 in.; beam, 63 ft.; depth, 40 ft.; draft, 27 ft.; displacement, 18,600 tons. She is guaranteed to make 18 knots under contract, and her 18,000 horse power engines are expected to drive her at a higher rate on trial. The *Korea* will be provided with accommodations for 200 first cabin passengers and more than 1,200 steerage passengers. Her sister ship, the *Siberia*, will be ready to launch in about a month. The two vessels will cost about $4,000,000.



GENERAL PLAN OF THE NEW DRY DOCK AT BALTIMORE, MD., FOR THE WILLIAM SKINNER & SONS' SHIPBUILDING AND DRY DOCK CO.

CONSTRUCTION OF THE NEW DRY DOCK AT THE SKINNER SHIPYARD, BALTIMORE.

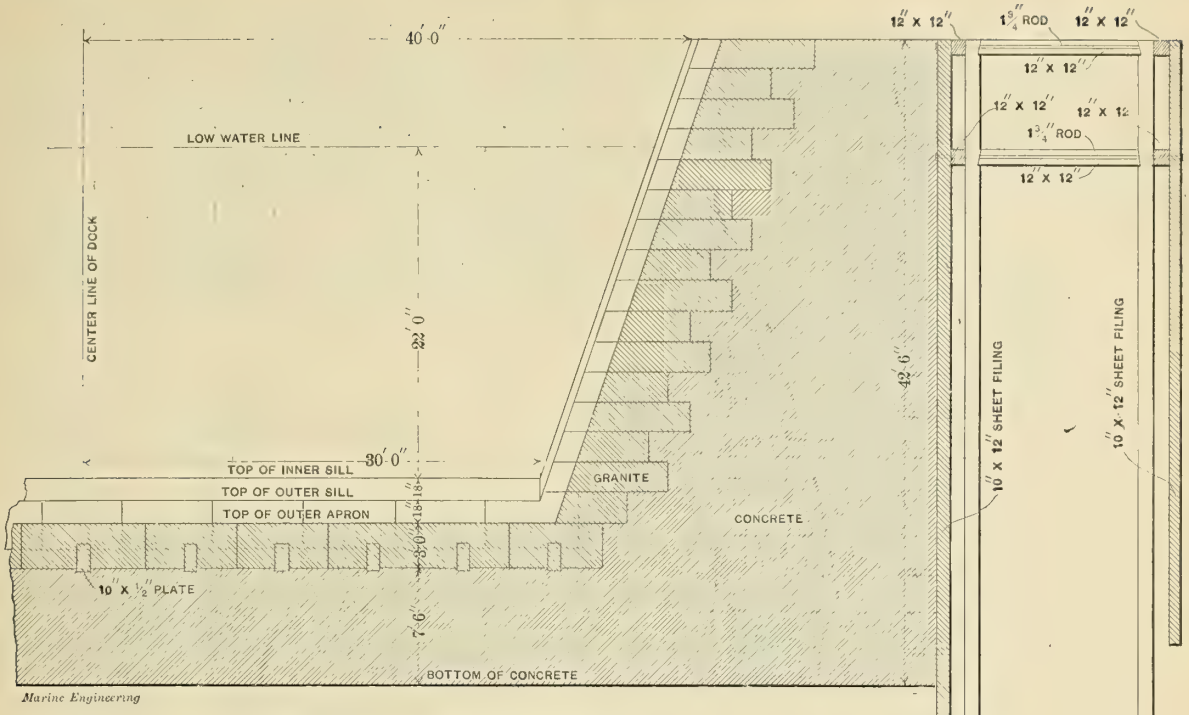
There is now under construction in the harbor of Baltimore, Md., a large dry dock for the William Skinner & Sons' Shipbuilding & Dry Dock Co., which will probably be opened for use about May 1, next. Contracts for the dry dock construction, pumping machinery, boilers and steel caissons were awarded in June and July, 1899, and the work has since progressed very satisfactorily. The accompanying plans and sectional drawings show the methods of construction, but do not fully indicate the difficulties which have been met with in the actual work.

The extent of the work can be appreciated by considering some of the contract figures: Excavation and dredging, 130,000 cu. yds.; concrete, 150,000 cu. ft.; granite masonry, 20,600 cu. ft.; piling, 100,000 lineal ft.; tongued and grooved sheet piling, 10 in. by 12 in. by 40 ft., 1,125,000 ft. B. M.; pine timber, 1,200,000 ft. B. M.; Oregon fir timber, 114,000 ft. B. M.; white oak timber, 175,000 ft. B. M. The principal dimensions of the dock are as follows:

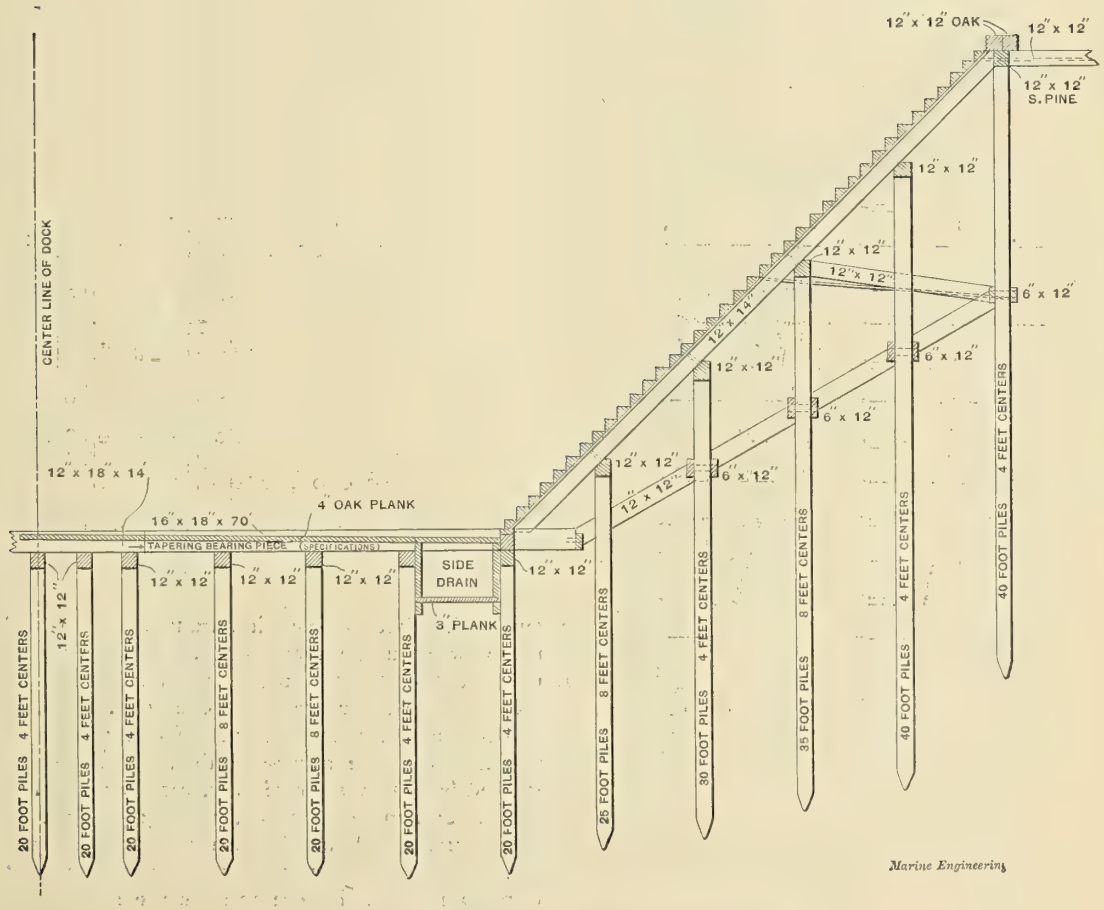
Length from head of dock to outside of apron	625	ft.
Width at bottom of dock	60	ft.
Width at top of keel blocks	67	ft.
Width at top of dock	125	ft.
Width of entrance at bottom	60	ft.
Width of entrance at top	80	ft.
Depth of water on inner sill at low tide	22½	ft.
Depth of water on inner sill at high tide	25	ft.
Height of coping above low water	6½	ft.
Height of coping above floor of dock	32½	ft.

The dock is located at the northerly side of the Skinner shipyard, and extends for a distance of 210 ft. into the harbor, to the Port Warden's line. This condition involved the construction of a permanent protection around this outer portion, consisting of a double row of sheet piling, the space between the rows being filled with earth. The outer end of this protection formed the temporary coffer-dam. At the outer and inner edges of the proposed abutments for protecting the entrance of the dock, there was driven across the slip—uniting the side protections—a line of sheet piling; the outer protections, the coffer-dam and these transverse bulkheads, were braced and trussed as the work of pumping out progressed, so as to prevent any chance of the bulkheads yielding to the outside pressure. This system of bracing, and the constant watchfulness of those in charge, have prevented the occurrence of any accidents, and the leakage of water has been of so small an amount as to cause very little delay to the work, especially when it is remembered that the bottom of the excavation was 36 ft. below low water.

The entrance aprons and abutments are built of Portland cement concrete, faced with granite masonry, and are now well advanced towards completion. The southerly abutment will contain the pump wells and the tunnel, connecting with the main part of the dock, and will support the pumping station and part of the boiler house. All of this work is of very massive construction, and will fully protect the entrance of the dock from any danger of injury from waves or ice, or from any tendency towards movement under pressure.



HALF CROSS SECTION THROUGH OUTER SILL.


CENTER LINE OF DOCK
12" x 18" x 14"
16" x 18" x 70"
4" OAK PLANK
TAPERING BEARING PIECE (SPECIFICATIONS)
SIDE DRAIN
3" PLANK
12" x 12" OAK
12" x 12"
12" x 12" S. PINE
12" x 12"
12" x 12"
12" x 12"
12" x 14"
6" x 12"
6" x 12"
6" x 12"
6" x 12"
20 FOOT PILES 4 FEET CENTERS
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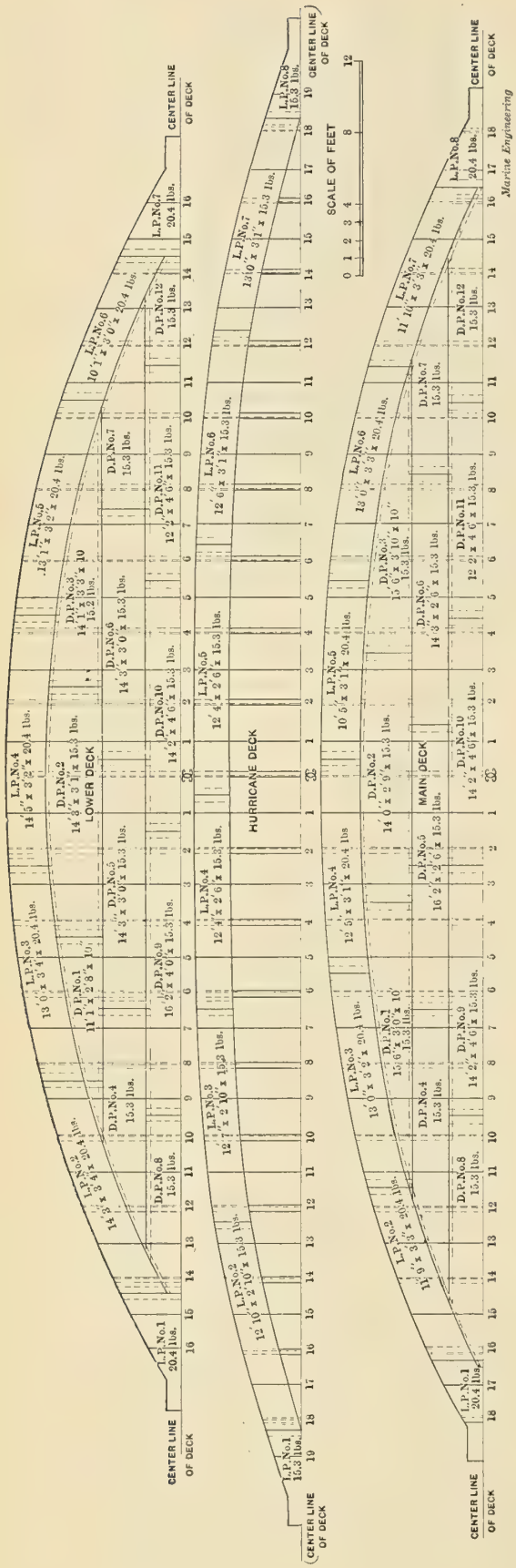
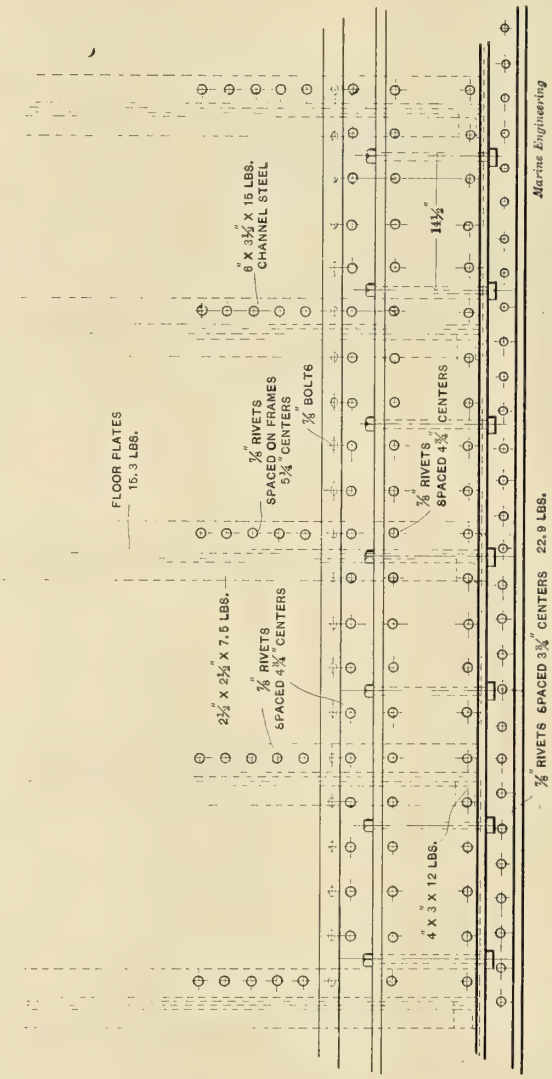
Marine Engineering

PILES AND TIMBERING OF DOCK AT MID-LENGTH.

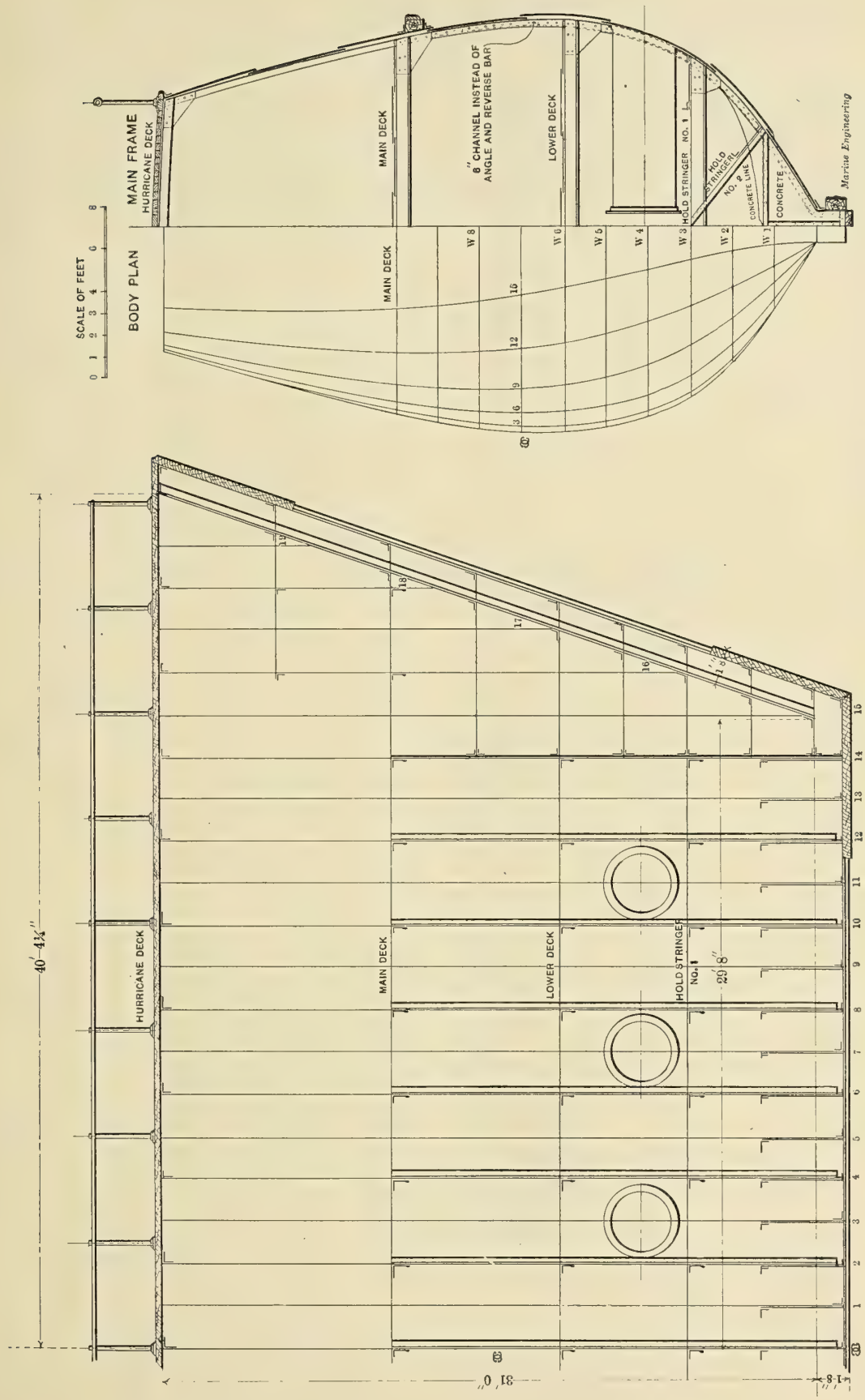


The main part, or basin of the dock, is constructed of timber and piling. The bottom of the dock is supported by thirteen longitudinal rows of piles, the two outer rows and the five rows under the keel blocks having the piles spaced 4 ft. on centers, and the other rows 8 ft. Upon each row of piles is placed a 12 in. by 12 in. Georgia pine cap, drift-bolted to the pile, and upon these caps are placed the transverse timbers. These are 16 in. by 18 in. Oregon fir, 70 ft. long every 8 ft., with an intermediate timber 14 ft. long, as shown on the plan. These timbers are se-


FLOOR PLATES 15.3 LBS.
6" X 3½" X 15 LBS. CHANNEL STEEL
⅞" RIVETS SPACED ON FRAMES 6¼" CENTERS
⅞" BOLTS
⅞" RIVETS SPACED 4¾" CENTERS
14½"
2½" X 2½" X 7.6 LBS.
⅞" RIVETS SPACED 4¾" CENTERS
4" X 3" X 12 LBS.
⅞" RIVETS SPACED 3¾" CENTERS 22.9 LBS.
Marine Engineering

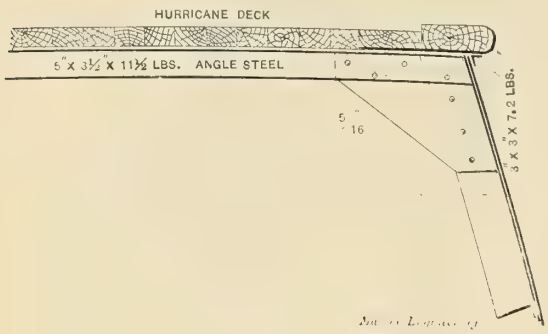
DETAILS OF SCANTLINGS AND RIVETING OF STEEL CAISSON.

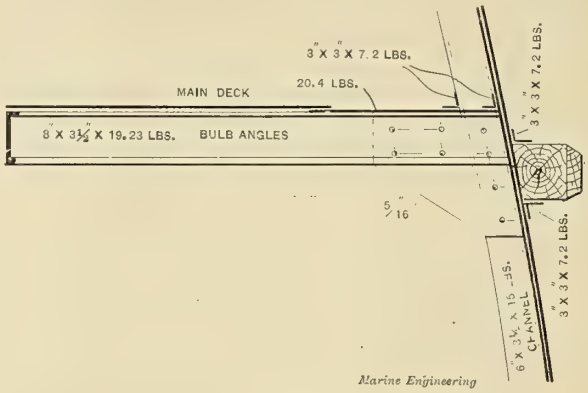
curely drift-bolted to each longitudinal cap, and the space between the timbers is filled with earth, well rammed and packed, to the under side of the floor planks. The latter are white oak, 4 in. thick, spiked to bearing pieces, which are supported upon the caps and spiked to the transverse timbers. Each slope is supported by five rows of piles, capped with 12 in. by 12 in. longitudinal timbers, upon which are placed the slope timbers, which are spaced 4 ft. on centers, and are alternately 12 in. by 14 in., and 8 in. by 14 in. Georgia pine. All these timbers are securely bolted and framed together, and the caps are drift-bolted to

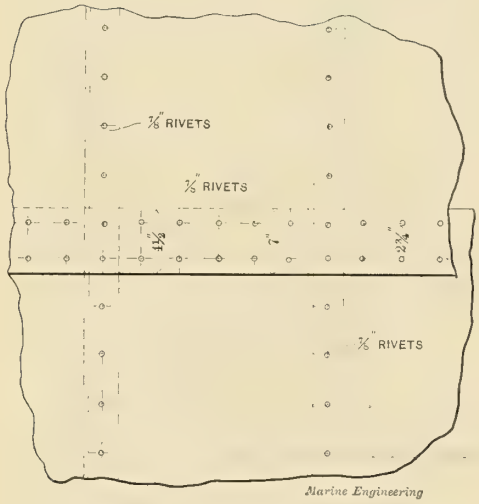


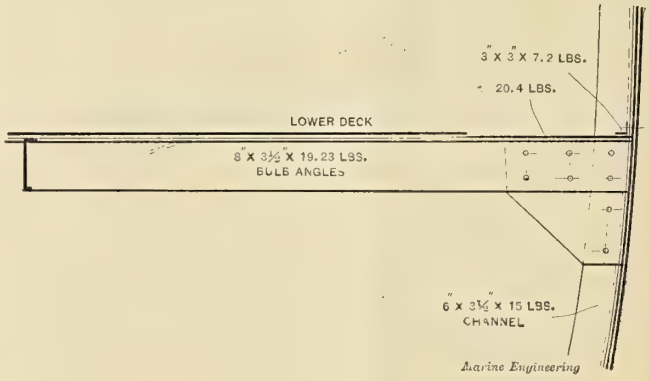
LONGITUDINAL AND TRANSVERSE SECTIONS AND BODY PLAN OF STEEL CAISSON FOR SKINNER DRY DOCK AT BALTIMORE, MD.

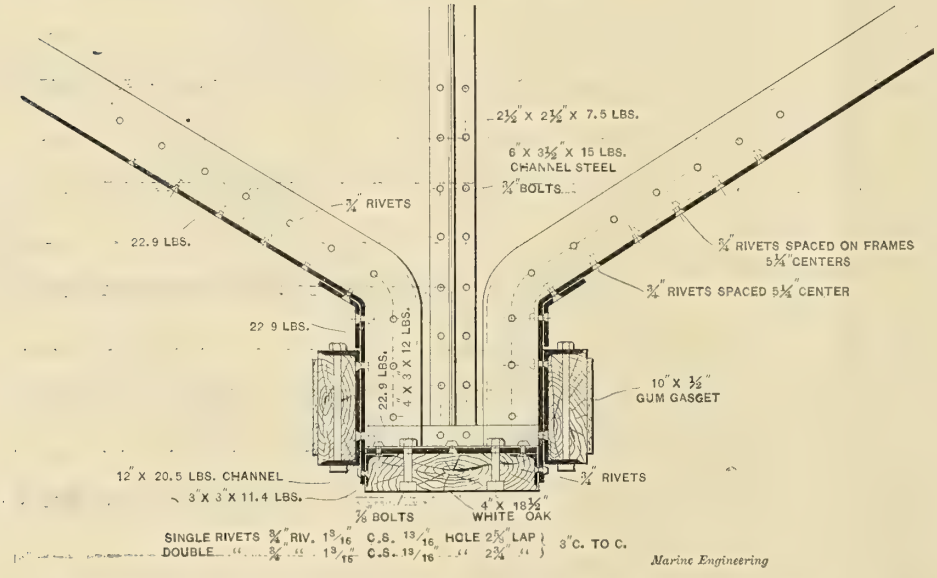
the piles. The lower ends of the 12 in. by 14 in. slope timbers are framed into the tops of the 16 in. by 18 in. transverse timbers, and the 8 in. by 14 in. timbers are framed into a 12 in. by 14 in. filler, which rests upon the outer longitudinal cap of the floor piling, and is framed into the sides of the 16. in by 18 in. transverse timbers. The slope piles are further braced by 12 in. by 12 in. timbers, extending from the outer ends of the transverse timbers to 6 in. by 12 in. walling pieces, bolted to each row of piles, as




3" X 3" X 7.2 LBS.
20.4 LBS.
MAIN DECK
8" X 3½" X 19.23 LBS. BULB ANGLES
5/16
3" X 3" X 7.2 LBS.
6" X 3½" X 15 LBS. CHANNEL
3" X 3" X 7.2 LBS.
Marine Engineering






2½" X 2½" X 7.5 LBS.
6" X 3½" X 15 LBS. CHANNEL STEEL
¾" BOLTS
¾" RIVETS
22.9 LBS.
¾" RIVETS SPACED ON FRAMES 5¼" CENTERS
¾" RIVETS SPACED 5¼" CENTER
22.9 LBS.
22.9 LBS.
4" X 3" X 12 LBS.
10" X ½" GUM GASGET
12" X 20.5 LBS. CHANNEL
3" X 3" X 11.4 LBS.
¾" RIVETS
⅞ BOLTS
4" X 18½" WHITE OAK
SINGLE RIVETS ¾" RIV. 1 13/16" C.S. 13/16" HOLE 2⅝" LAP } 3" C. TO C.
DOUBLE " ¾" " 1 13/16" C.S. 13/16" " 2¾" "
Marine Engineering

STRUCTURAL DETAILS OF STEEL CAISSON FOR SKINNER DRY DOCK AT BALTIMORE, MD.

shown on the cross section. The slope timbers are sheeted with 1 in. white pine boards, and upon these are placed the altars. Behind the boards and between the slope timbers and piling, earth is filled in and packed solid. At the easterly end of the dock, on its north side, concrete is to be used instead of earth filling, because the distance from the dock to the outer bulkhead is so small at this point, that it was deemed safer to provide extra protection there.

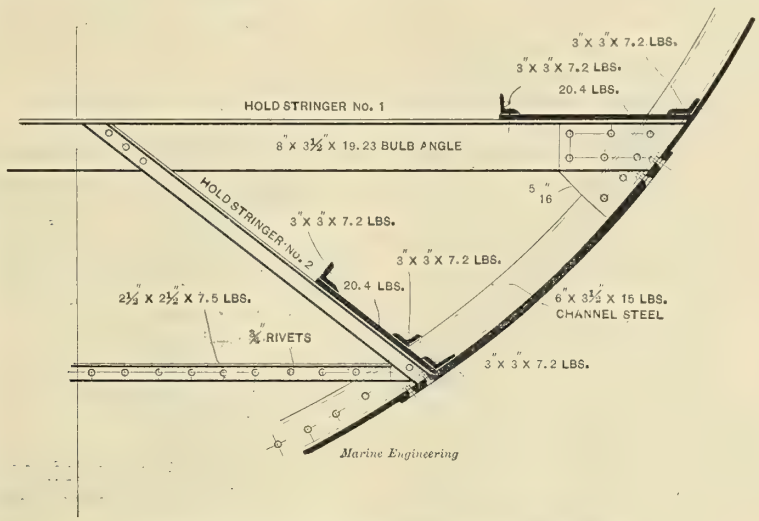
There will be two longitudinal drains, one at each side of the dock, and the floor is laid so as to shed water from the center of dock to the sides, which arrangement will keep the space under the keel blocks always dry when work is being done.

The side drains terminate at the inner apron and discharge into a cross drain, which connects with the tunnel leading to the pumps. The pumps are set on the concrete floor of the power house, at an elevation of 10 ft. above the floor of the dock. The suction pipes extend down to about 4 ft. below the level of the floor of the dock, into the water chamber. There are

The contract for the construction of the protection bulkheads, masonry and concrete, piling and timber work, and the power-house was awarded to the Delaware Construction Co., of Wilmington, Delaware, and they have given the work careful attention, and fully justified their selection. They have cheerfully performed very difficult work in excavating to the depth required, handling the bracing, and in performing any and all special work they have fully satisfied the owners of the dock and the engineers in charge.

The Spedden Shipbuilding Co., of Baltimore, is building the steel caisson; The Morris Machine Works, of Baldwinsville, N. Y., furnishes and puts in operation the pumps and engines; the Heine Safety Boiler Co., of St. Louis, has the contract for the boiler plant complete.

The plans and specifications were prepared and the work is being superintended by James Ritchie, civil engineer, of Cleveland, Ohio, and the assistant engineer in immediate charge of the work under construction is C. P. Ruple, of Cleveland, Ohio. The



STRUCTURAL DETAILS OF CAISSON FOR SKINNER DOCK.

three pumps each having a 36 in. discharge, and one drainage pump having a 14 in. discharge. The three main pumps are calculated to empty the dock in 1 hour and 30 minutes, and the drainage pump to overcome any leakage which may occur while the dock is in use. Steam will be furnished by three boilers of the water-tube type, operating under forced draft, and one auxiliary vertical tubular boiler. The latter will be used to furnish steam for operating the drainage pump, and for the engine which drives the draft fan, also for the pump used in emptying the caisson gate. The power-house will be of brick, with a slate roof and steel trusses.

The steel gate consists of a caisson, giving a clear opening of 60 feet at the sills, and 80 feet at the top of dock, being so constructed as to be floated into place and then sunk, entirely closing the entrance. It has six 36 in. gate valves for filling the dock, and four 6 in. valves for use in filling the gate, and is provided with a pump for emptying the same. The accompanying drawings show the details of construction and the dimensions of the various parts.

arrangement of the pumping plant and the boilers was under the immediate charge of Charles L. Reeder, mechanical engineer, of Baltimore.

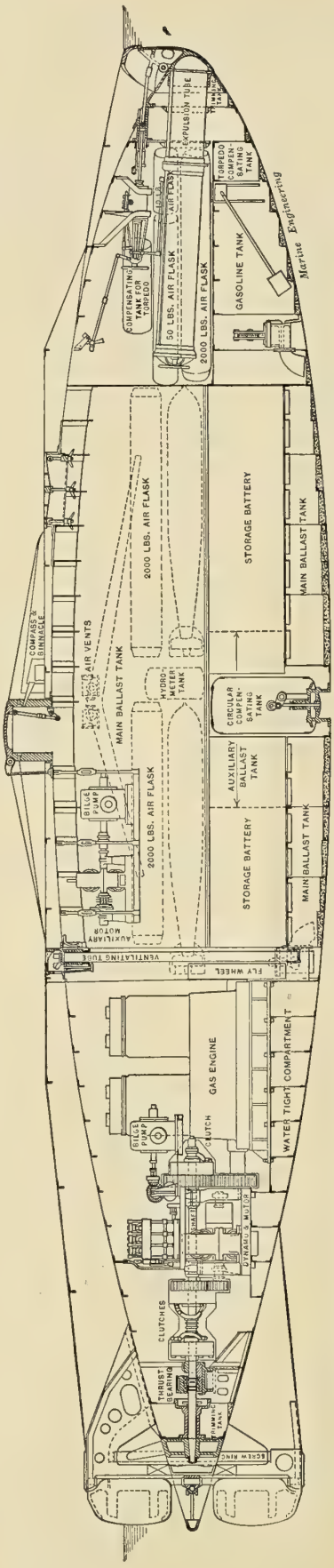
BUILDERS' TRIAL.—A very successful builders' trial of the new double screw ferryboat *West Point* for the West Shore Railway took place in the Hudson river last month. The contract for the construction of this vessel was let to the W. & A. Fletcher Co., Hoboken, N. J., who sublet the contract for the hull to T. S. Marvel & Co., Newburg, N. Y. The contracting firm built the engines and boilers and completed the ferry for service. The *West Point* is of the following dimensions: Length, over all, 208 ft.; between perpendiculars, 178 ft; beam, molded, 40 ft; over guards, 66 ft.; depth, molded, amidships, 18 ft.; height from water to top of plankshear at ends, 6 ft. 9 in. The boat is fitted with double, vertical compound jet condensing engines, with cylinders 18 in. and 38 in. dia. by 28 in. stroke. Two boilers of the Scotch type are fitted, each 12 ft. 9 in. dia. and 11 ft. long. During the trial the machinery worked with great smoothness.

CONSTRUCTION AND TESTS OF SUBMARINE TORPEDO BOATS FOR THE U. S. NAVY.

In naval circles, the world over, the most interesting topic of discussion at the present time, probably, is the submarine boat. Both France and the United States have committed themselves to this type of fighting ship by the award of contracts for the construction of submarine boats. Those now building for our Navy are of the familiar Holland type. In the accompanying engraving is shown the general interior arrangement of the new vessels, of which there are six under construction. The completed *Holland* and incomplete *Plunger* bring the total up to eight. Of the new boats, the *Adder*, *Moccasin*, *Porpoise* and *Shark* are building by Lewis Nixon at the Elizabethport, N. J., shipyard, and the *Grampus* and *Pike* at the Union Iron Works, San Francisco, Cal. In dimensions these boats measure: Length over all, 63 ft. 4 in.; diameter, 11 ft. 9 in.; displacement, submerged, 120 tons. They are provided with single screws and four-cylinder Otto gasoline engines of 160 I. H. P., and have also main electric motors of the water proof type of 70 horse power. There is capacity in the storage tanks for 850 gallons of gasoline, and the speed, submerged or awash, is estimated at 7 knots. Armament consists of one torpedo expulsion tube, for which there are provided five 45 c. m. by 11 ft. 8 in. Whitehead torpedoes. The conning towers are 21 in. dia. and are protected with 4 in. of armor. The contract price for the hull and machinery of each of these boats is $170,000, and the dates of completion range from the present month to July next.

In his last annual report the retiring chief of the Bureau of Construction and Repair, Admiral Hichborn has this to say on the question of submarine boats:

> The interest of this Bureau in the development of the submarine vessel has been great, as witnessed by the references which have been made in its reports from time to time, the consideration which it has given to the many propositions relating thereto which have been submitted to it, and the assistance which, wherever practicable, it has given to those working in this direction. From the essentially experimental character of the work being done it has, however, refrained from comment thereon or recommendation as to future policy.
>
> The past year has brought to fruition the experimental work covering a considerable period and has demonstrated the practicability of the submarine boat. The vessel which the Department recently acquired has shown herself capable of such perfect control in the vertical plane that she may be kept within a few inches of any desired depth while moving, or brought to the surface and taken under again in a very short time; her direction and control in the horizontal plane on the surface is effected with the same facility as any other craft, and submerged is limited only by the difficulties of vision. Her crew are provided for on board with reasonable comfort and perfect safety for such periods as she may be in service,



CHIEF CHARACTERISTICS OF THE SUBMARINE BOATS, ADDER, GRAMPUS, MOCCASIN, PIKE, PORPOISE AND SHARK, NOW BUILDING FOR THE U. S. NAVY.

and working either upon the surface or submerged; and her armament, consisting entirely of torpedoes, gives her great offensive power.

In spite of the unsuitableness of the forms of power generators at present available for a vessel running both on the surface and submerged, there is attained, under both conditions, a speed which, while not all that is desirable, will make the vessel capable of efficient service as an element for coast defense.

Of the possibilities in the application of efficient submarine vessels to coast defense work it is not necessary to speak; nor is it necessary to do more than mention the economy of men and money in this form of defensive preparation and the moral effect upon an enemy which will come from a knowledge that we possess and are employing for coast and harbor defense vessels of so great possibilities. At least one European nation having a considerable coast line to defend has entered seriously upon the construction of submarine vessels, and has in hand, or projected, a considerable number of this class of vessel.

Experience has shown that the appearance of any particular type of fighting craft in sufficient numbers to make its possibilities a factor to be considered, forces modifications in types previously existing. That this should be particularly the case with submarine vessels there is every reason to believe, and there can be little doubt that to the first nation in the field with the new type will accrue not only the advantages which will come from the possession of efficient vessels of this type, but the additional advantage in saving in cost which will result from an early understanding of the new type and the modifications which its introduction will force in existing types.

Trials of Holland Boat.

Trials of the submarine torpedo boat *Holland* were conducted by the Navy Department in January for the purpose of collecting data in regard to the steaming radius of the boat when running on the surface. The Bureau of Steam Engineering was represented by an expert engineer officer, Lieut. Comdr. John R. Edwards, U. S. N., and the boat was under the command of a navigator, Lieut. H. H. Caldwell, U. S. N. The reports made by these officers are very interesting reading, as, we believe, they are the first expressions of opinion on this particular type of boat, made by disinterested experts, which have appeared in print. We here reproduce the reports from the semi-official *Journal of the American Society of Naval Engineers*. The report of Lieut. Comdr. Edwards as follows:

BRIEF DESCRIPTION OF THE HOLLAND.

The hull of this submarine boat is practically a spindle, every vertical transverse section of which is a circle. The greatest diameter is about 11 ft., the ends being about 3 ft. With such a contour the mechanical appliances must necessarily be crowded together.

Under surface propulsion the motive power is a gas engine of about 45 horse power. From the shaft of this engine a set of gearing operates the propeller shaft. For want of air, as well as by reason of the danger of using gasoline, this engine cannot be worked under water.

For submarine propulsion electric motors are used. These motors are worked by a current of electricity from a storage battery. The main motor, through a set of gearing, works the propeller shaft, while the auxiliary motor operates the bilge pump and also an air compressor.

There is a steering engine for working the vertical rudder and a diving engine for working the two horizontal rudders. These two engines are worked by air from six storage flasks. These two engines have oil-controlling cylinders.

There is a storage battery which is charged by the gas engine working a dynamo. This dynamo is convertible into the submarine propelling motor. There is also an ignition battery for producing explosion in the gas engine. This small battery is of low voltage and is also charged by the gas engine.

The storage flasks are charged to 2,000 lb. pressure. The steering and diving engines are worked by an air pressure of 50 lb., a reducing valve preventing higher pressures reaching these appliances. A pressure of only 10 lb. is required for blowing out the submersion tanks, another reducing valve controlling this pressure.

TIME OF TRIAL.

The *Holland* started from Annapolis 1.30 P. M. Tuesday, January 8, and reached the navy yard, Norfolk, about 1.30 P. M., Thursday, January 10. She was actually under way twenty-five hours and thirty-six minutes. She made one stop of about three-quarters of an hour on account of the propeller motor gearing running warm. She made a second stop of about five hours to recharge the storage battery. This stop was made sixteen hours after she left Annapolis. A third stop of two hours was made on account of the after line bearing becoming warm. After she had been under way, repairing, or charging her storage batteries for thirty-six hours she anchored for about thirteen hours to give the running crew a needed rest.

DISTANCE.

The actual distance run by the *Holland*, as furnished by her commanding officer, was 145 miles.

WEATHER.

The weather throughout the trip was favorable for the trial. I was informed by the boatswain commanding the U. S. tug *Standish*, which convoyed the *Holland*, that probably at no time during the winter would conditions be more favorable for the test. The boatswain commanding the *Standish* has been taking tugs up and down the Chesapeake for the past ten years, and he ought to be particularly well qualified for giving an opinion as to the weather conditions.

When the wind was against the tide during the trip there was a little sea. There was no fog at any time, and only for three short periods was there any rain. In general, more favorable conditions could not have been expected at this season of the year.

SPEED.

The trip was entirely a surface run. While actually under way the speed secured was exactly 5 2-3 knots. The maximum speed over the ground was 7 knots. There was no log-recording machine on either the *Standish* or the *Holland*, so the speed could only be as-

certained by noting the time between shore stations. The tide question can be thrown out of consideration, since the *Holland* had as much tide in her favor as against her.

DISPLACEMENT.

The *Holland* had about 18 in. free board. Her three torpedoes had been left on shore. The oil tanks were practically full. For about one-third of the time two extra passengers were carried, in addition to the regular Navy crew. For two-thirds of the time only one passenger was carried beyond the regular crew.

PERSONNEL.

There was a thoroughly competent and trained crew in the boat during the run. Two years ago I watched the civilian crew of the *Holland* manipulate her machinery, and the Navy crew was their equal in nerve, skill and readiness of resource. The *Holland* was, therefore, not at any disadvantage in respect to personnel.

For months preceding the time that the Navy crew were placed in charge, Lieut. H. H. Caldwell, the commanding officer of the *Holland*, had seen the civilian crew of the submarine boat work her appliances, and therefore he had an excellent chance to compare the efficiency of the two crews. Lieutenant Caldwell not only informed me that the Navy crew were perfectly familiar with the working of the *Holland*, but also that the various mechanical appliances were in better condition than when the Navy crew were placed in charge.

For hours I personally watched the Navy crew carry on their work, and they were thoroughly competent to perform their duties.

CASUALTIES.

While starting up the electric motor, after stopping to charge the batteries, one of the bars of the armature of this motor burnt out, thus entirely throwing the electric propelling engine out of use.

Fortunately for the test, both the storage and ignition batteries as well as four of the six air flasks had been completely charged; otherwise the test might have ended at that point. The disablement of this motor prevented the propeller backing. It also prevented the recharging of the air flask and storage batteries. The boat would therefore be helpless when either the air supply, the ignition current, or the storage electric current should be exhausted.

CONDITION OF MACHINERY.

The armature of the dynamo had been turned over to the Government in an impaired condition. Previous to the acceptance of the *Holland* by the Navy Department this submarine boat had been sunk by accident somewhere on Long Island Sound. The salt water had impaired the armature, and thus trouble has been had with the motor ever since.

The impairment has been of such a nature that mechanics from Philadelphia have heretofore been called upon to fit new bars to the armature. The Holland people have also appreciated the serious condition of affairs, for at their own expense they are now having a new armature made, which will be ready for installation shortly.

With the exception of the impaired dynamo, which the Navy crew was not at all responsible for, the condition of machinery was very good. I was informed by the commanding officer of the *Holland* that it was now in better shape than when it was turned over to the Government.

Both the propeller and driving shafts need lining up. I understand the Navy crew have improved matters in this respect also, for a hot bearing was a much more frequent occurrence when they took charge than it is now.

OIL CONSUMPTION.

While actually under way the average oil consumption was 5 gal. per hour. The oil tank capacity is about 1,300 gal. The oil used during the entire trip between Annapolis and Norfolk was 175 gal. If it was only a question of oil consumption, therefore, the boat would have a large steaming radius.

ENDURANCE.

The endurance of the *Holland* is not only dependent upon her fuel supply, but also upon the physical strength of the crew. Careful watch must be kept while the batteries are being charged, as well as when the propelling engines are in operation, and there must naturally be a limit as to the time when men can remain continuously at work.

The facilities for sleeping, as well as for cooking, must be limited, and it is therefore a question as to whether the crew can remain aboard at sea for rest.

TEMPERATURES.

Since the *Holland* is practically a steel spindle and has no non-conduction substances over her hull plates, the temperature during the test did not rise over 60 deg. Fahr. In fact, it was so cold that one of the crew told me that he was not able to sleep while not standing watch.

During the first half of the run two electric heaters were used to make the men comfortable. During the last half of the run it was not deemed advisable to use them, since they consumed so much current of electricity that it was apprehensive that the storage battery would run down.

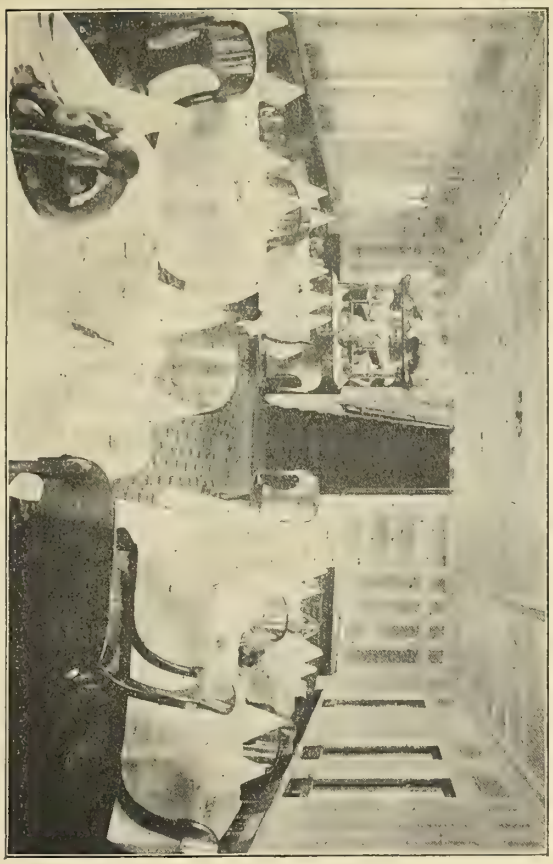
Since the sea was smooth during the speed-endurance trial, the ventilators and the hatches, of course, could be used in the most efficient manner for securing desirable temperatures.

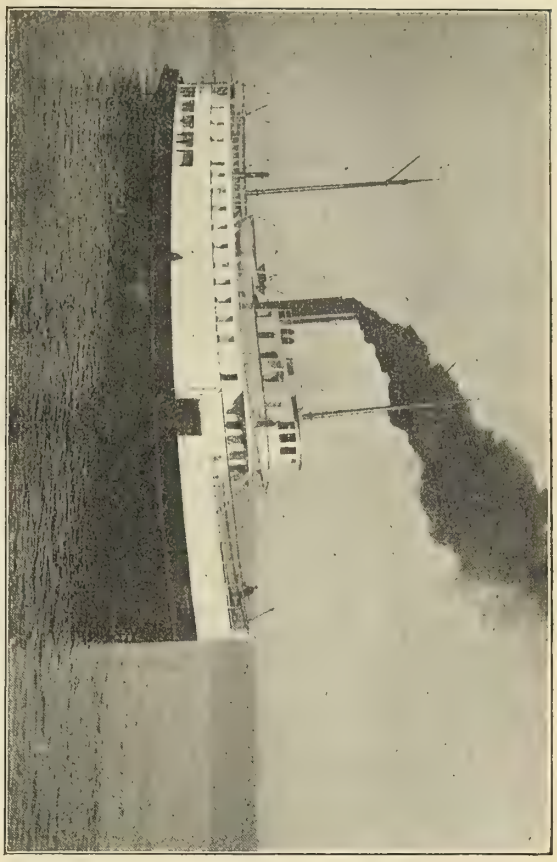
(To be continued.)

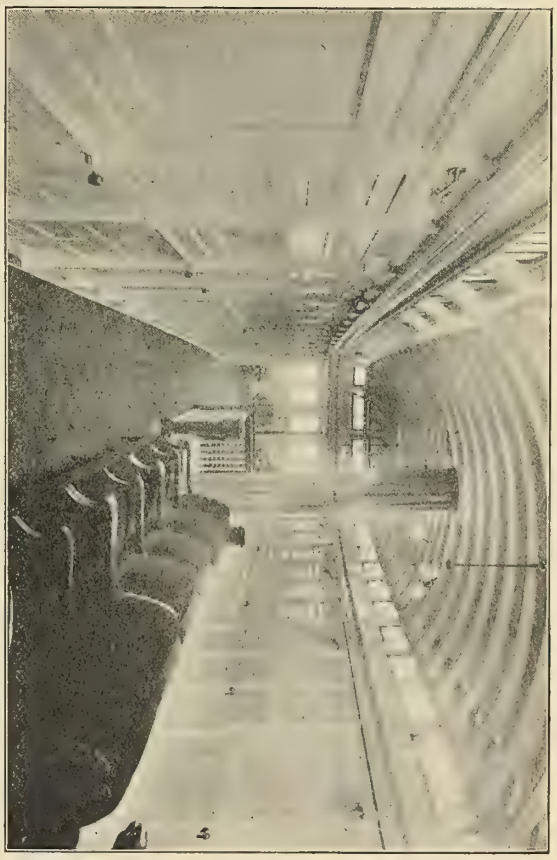
Puget Sound Steamer Mainlander.

Supplies of timber suitable for vessel construction are so abundant along the Pacific coast that in home waters there the wooden vessel is extensively used. An addition to the Pacific coast fleets, made by a Puget Sound firm of builders, is shown in the accompany reproductions of photographs, which give a good idea of the modern practice in that section. These are of the steamship *Mainlander*, owned and operated by the Western Steam Navigation Company, more generally known as the "Vancouver Line." She is engaged in the freight and passenger trade of the line between Tacoma, Seattle and Vancouver, and was named in honor of the people of Vancouver, the term "Islander" and "Mainlander" being used to designate, respectively, the residents of Vancouver Island and Vancouver City.

The *Mainlander* is built of specially selected winter







PHOTOGRAPHS OF THE VANCOUVER LINE WOOD STEAMER MAINLANDER (BUILT IN PUGET [SOUND] AND OF THE PASSENGER ACCOMMODATIONS.

cut Douglas fir, Oregon pine, and is very strongly kneed and fitted with seven keelsons running the entire length. She is fastened with locust treenails and galvanized iron. Her dimensions are: Length 162 ft.; beam 28 ft.; depth molded 12 ft. 6 in. Both the hull and the joiner work were constructed at the yard of Crawford & Reid, Tacoma, Wash., and the engines were built by John B. Hardy, of Tacoma. They are of the 3 cylinder triple expansion type, with cylinders 16 in., 27 in. and 44 in. dia. by 24 in. stroke. Seabury water tube boilers are fitted. There is bunker capacity for 60 tons of coal, and in service the consumption is about 1,300 lb. per hour. A speed of 14 statute miles is attained.

There are accommodations for 93 passengers in 31 staterooms which are fitted with Hartford link springs in enameled iron frames. On the main deck there is a spacious dining room aft, with pantry gallery and crew's mess adjoining. The remainder of the deck is used for freight, the smoking room and the crew's quarters being below. The upper house is brought out flush with the lower, thus giving more room in the main saloon and observation room forward. White enamel and mahogany are used for the inside finish. The *Mainlander* was designed by E. L. McAllister, Seattle, Wash.

U. S. S. Preble.—The torpedo boat destroyer *Preble* was launched from the yard of the Union Iron Works, San Francisco, Cal., last month. The *Preble* is one of the sixteen destroyers authorized by Act of Congress of May 4, 1898, and is of these dimensions: Length, 245 ft.; extreme beam, 23 ft. 7 1-4 in.; mean draft, 6 ft. 6 in.; displacement, 420 tons. She will be fitted with twin screw vertical triple expansion engines and Thornycroft boilers, and is expected to attain a speed of 29 knots. Her armament will consist of two long 18 in. Whitehead torpedo tubes, two 3 in. R.F. and five 6-pdrs. R.F. The contract price for the hull and machinery of the *Preble* is $250,000.

S.S. El Valle.—The Morgan Line steamship *El Valle* was launched at the Newport News Shipbuilding and Dry Dock Co., Newport News, Va., yard last month. This is the ninth of the fast coastwise freighters built at this yard for the Morgan Line service between New York and New Orleans. Her dimensions are: Length over all, 406 ft.; beam molded, 48 ft.; depth, 33 ft. 9 in. The construction of these vessels is under the supervision of Horace See, of New York, consulting engineer for both the Morgan and Cromwell lines.

S.S. Venus.—The steel freight steamer *Venus* was launched from the Lorain, Ohio, yard of the American Shipbuilding Co. last month. The vessel which was built to the order of J. G. Gilchrist and others, is of these dimensions: Length, 366 ft.; beam, 48 ft.; depth, 28 ft.. The *Venus* is the third of a fleet of eight steel steamers which will be built by the American Shipbuilding Co. She will be fitted with all improvements for handling cargoes and also for the convenience of her crew.

A builders' trial of the U. S. torpedo boat *Shubrick* is reported to have resulted in a speed of 28.3 knots.

ACTION OF BILGE KEELS FROM A HYDRODYNAMICAL POINT OF VIEW.—IV.*

BY G. H. BRYAN, F.R.S.

IV.—EFFECT OF PRESSURE-VARIATIONS AGAINST THE SIDES OF THE SHIP (CONT'D.)

In the Appendix I shall give formulæ by which the pressure can be calculated at any point of the portion $A\ B$ of the $\llcorner$, especially when the angle $A\ B\ C$ is a right angle, as in Fig. 10. In every case the resultant thrust on $A\ B$, depending on the excess of the pressure along $A\ B$ over the pressure in the dead water, can be made as great as we please, by taking a sufficient length for the portion $A\ B$. In fact, as we go along the arm $B\ A$, the velocity, starting at zero at B, continually increases, until, at an infinite distance from B, it becomes equal to the velocity q at the surface of discontinuity. The excess of pressure due to the projection $B\ C$ thus decreases from $\frac{1}{2}\rho q^2$ at B to zero at an infinite distance along $B\ A$. In the case of the ship, however, the effects depend on the *moments* of the differences of pressure about O, and we are limited to a consideration of those parts of the boundary where the pressure have a moment about O opposed to rotation. In a section such as Fig. 6, this moment vanishes at A_0 and A_2, and is also small in the part where the contour is rounded off close up to A_1.

From another point of view, however, the ship has an advantage. If we compare (Fig. 12) the motion of the fluid past the right-angled $\llcorner$, shown at $A\ B\ C$, with the motion past a protruding portion of a ship

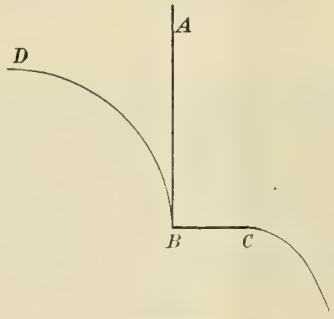


FIG. 12.

$D\ B$, with the bilge keel $B\ C$ projecting from B, we must remember that, if the keel were removed in the first case, the velocity along $A\ B$ would be constant, while in the second case the velocity along $D\ B$ would decrease from B towards D. The same thing is evidently true with the bilge keel added, and the velocity being less with $D\ B$ as boundary than with $A\ B$, the pressure is greater. In the regions of dead water the motion is comparatively feeble, and no counterbalancing differences of pressure are set up; such as would exist in the absence of bilge keels where the fluid flows freely round the corners.

(13) Another illustration of the property considered above, viz., the effect of a projecting edge in increasing the pressure on a surface to which it is at right angles, is shown in Fig. 13. If the lamina $D\ B\ C$ of Fig. 9 have ridges attached to its edges D, C, their effect has been found by Love to increase the thrust

*Read before the Institution of Naval Architects, London.

on the lamina by an amount approximately equal to 6-5 $\sqrt{e}$ of itself, where e is the ratio of the height of the rim to the breadth of the disc.

V.—EFFECT OF CHANGES OF MOTION, OR $\frac{d\phi}{dt}$ PRESSURES.

(14) Hitherto we have only taken account of the pressures which would be produced on and by the bilge keels, if the relative motion of the fluid at each

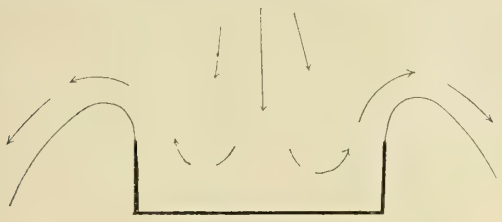


FIG. 13.

instant were regarded as a steady motion during a small interval of time, including that instant. But as the motion of the ship is oscillatory, further changes of pressure are produced in each swing as the angular velocity of rotation increases and decreases. The exact effect of these changes would be very difficult to investigate mathematically for a ship with bilge keels, as the only problems in discontinuous motion which have yet been solved are cases of *steady* motion past boundaries formed by one or more *planes*. We may, however, easily see that the addition of bilge keels completely alters the character of these changes.

It is to be observed that the pressure equation of hydrodynamics for variable motion takes the form

$$\frac{P}{\rho} + V + 1\text{-}2\ q^2 + \frac{d\ \phi}{d\ t} = C$$

where φ is the velocity potential. This equation holds throughout the fluid, except where vortices or discontinuous motions exist; at a surface of discontinuity the velocity suddenly changes without any corresponding change in the pressure, just as in steady motion.

We are now concerned with the terms represented by $d\varphi/dt$ in the above pressure equation. We may call these "$d\ \phi\ /\ d\ t$ pressures,' those previously investigated being distinguished as " 1-2 q^2 pressures."

(15) Consider first a cylinder or other body moving in liquid devoid of viscosity, the cylinder having no sharp edges projecting into the liquid, so that any protruding parts of its contour are rounded off, as in the case of a ship without bilge keels. When the cylinder is set in motion, stream-line motions of the liquid are set up, as investigated in an earlier section; but, as soon as the cylinder is brought to rest, the liquid will also come to rest. These changes involve no dissipation of energy, and the only effect of the fluid pressures is to increase the inertia of the cylinder. The time of swing will thus be lengthened, but no extinction of oscillations will take place.

But when bilge keels with sharp edges are added, the case is entirely different. The surfaces of discontinuity, once thrown off into the interior of the liquid, cannot be altered or destroyed by stopping or reversing the motion of the cylinder. The dead water, which is dragged along in the region behind the bilge keel in one-half oscillation, is projected outwards, with a free stream line, in the succeeding half oscillation. The motion is thus *irreversible*, and is accompanied by dissipation of energy. The general result is to throw the liquid into a state of turbulence.

(16) In the purely theoretical aspect of the question, the impossibility of destroying free stream lines depends on the principles: (1) That a surface of discontinuity is equivalent to a vortex sheet; (2) that vortices always contain the same particles of fluid; (3) that vortex motion cannot be set up or destroyed in the interior of a perfect fluid. Practically viscosity causes the vortex motion to diffuse outwards from the sheet, according to the same laws by which diffusion of heat takes place. This will cause the motion to assume the form of eddies, but is not likely to seriously affect the bilge keel resistances considered in the previous sections.

(17) One effect connected with the pressures due to changes of motion may be noticed, namely, the effect of the speed of the ship in increasing bilge-keel resistance, due to the keels constantly coming in contact with fresh portions of liquid that have not been set into turbulent motion by previous oscillations. This effect is analogous to the effect of lateral velocity in increasing the air resistance of planes, which has been very fully investigated by Professor Langley, Mr. Maxim, and many others in experiments conducted in connection with the problem of artificial flight.

(18) It is obvious that the effect of the $d\ \varphi\ /\ dt$ pressures must be largely affected by the same causes that we have shown produce such a marked increase in the extinctive moment of the 1-2 q^2 pressure, viz., the increased velocity of discontinuous motion due to the non-circular section of the ship, and the moments of the pressure variations on the sides of the ships. Their effect will thus be widely different (except for a ship of circular section) from the corresponding actions on a plane lamina moving through water. In fact we have to take account of the accelerations imparted to the masses of dead water behind the protruding parts of the ship to which the bilge keels are attached, and not merely to those which would be entrained by the bilge keel if the ship were absent.

Practically the result of the fact that the motions set up when the ship begins to swing are not annihilated when it comes to rest is to set up currents in the liquid as mentioned later on, and on the production of these currents is sufficient to account for a considerable absorption of energy.

VI.—COMPARISON OF RESULTS.

(19) Sir William White tells us that if the whole of the increased extinction in the *Revenge* be represented by an increased co-efficient of resistance of the bilge keel, this co-efficient would come out to vary between 8 and over 16 lb. per sq. ft.; while, if we represent in this way only those terms determining the extinction curve, which vary as the square of the amplitude, the corresponding computed resistance co-efficient comes out to be about 6, and remains constant for all amplitudes. This value is rather less than

four times the value (1.6) found experimentally for a plane area.

Now we have seen that the increased relative velocity of the fluid due to stream-line motions past the side of the ship may suffice to more than double the bilge keel resistance. In order to account for a further doubling of the effective resistance, it is only necessary to assume that the retarding moments of the pressure differences induced on the sides of the ship is equal to the moment of the pressures on the bilge keels themselves—a very reasonable hypothesis.

(20) If this view be accepted, there remains still unaccounted for the terms in the extinction curve, which are proportional to the first power of the amplitude, and the idea at once suggests itself that what we have called the $d\Phi/dt$ pressures may be largely responsible for the increase in the value of these. Owing to the difficulty of investigating these pressures mathematically, it is desirable that the matter should be put to an experimental test. It is certain that these pressures have no inconsiderable influence, and the point at issue is whether they account for the whole or part of the remaining extinctive effects; and, if the latter, for what proportion.

VII.—SUGGESTED EXPERIMENTAL VERIFICATIONS.

(21) The question as to how far actual bilge-keel resistance can be accounted for by discontinuous motions alone, without invoking the aid of dissipation of wave-making energy, could be tested by laboratory experiments on cylinders oscillating totally immersed in fluids with fixed boundaries, so that no wave formation is possible. Such cylinders could easily be set oscillating by attaching them to pendulums.

The case of a cylinder half immersed in liquid bounded by a rigid horizontal plane with the object of preventing wave formation, the boundary having just sufficient opening to allow free play for the oscillations of the cylinder, would be of considerable interest. A similar result could also be got by making the upper part of the cylinder of such a form as to give zero vertical velocity across a horizontal plane as suggested in Fig. 4.

Further information could be doubtless obtained as to the ultimate fate of the discontinuous surfaces by injecting colored fluids into the water, either as close as possible to the edges of the model bilge keels, or along alternate quadrants of the section. Such experiments would test a point which we have not yet considered, namely, the action of the bilge keels in producing circulating motions of the liquid; in particular that of sucking the water in at the sides and bottom of the ship (A_0, A_2, A_4, of Figs. 6 and 7), and projecting it outwards in the regions traversed by the bilge keels during their oscillations. Professor Hele-Shaw's beautiful experiments with thin liquid films, unfortunately, would not answer the purpose in cases where the discontinuous motions in these are almost at once broken up by the enormous influence of viscosity. The turbulence which breaks up the colored bands with thick films no doubt makes observations very difficult, but it is precisely this turbulence of which we want to take account in practice.

Lastly, experiments with vertical cylinders, with tubes let into them at various points, would enable the pressure variations on the sides of the cylinder itself to be measured. Practically, a long oscillating or rotating vertical cylinder, projecting above the water, shows the same effects by the heaping up of the water in front of the projecting edges, and moreover shows the eddies thrown off very readily. A little dust scattered on the surface, will show the currents produced in the liquid. Since writing the last words, we have tested the point in a simple way, by scattering powdered sealing-wax and bits of paper in a basin of water, and causing a glass plate to oscillate about a vertical diameter. In this way anyone can easily see for himself the particles being sucked in at the middle of the plate, and shot out when they reach the ends.

VIII.—CONCLUSIONS.

(22) (i.) The efficacy of bilge keels in extinguishing rolling oscillations is largely due to their action in setting up discontinuous motions in the water.

(ii.) This action depends not only on the bilge keels themselves, but also largely on the form of the section of the ship, and the position in which the keels are fixed.

(iii.) The influence of the form of the ship depends on two causes, namely (*a*) the effect of the stream line motions past the sides of the ship in producing counter-currents against a suitably placed bilge keel; (*b*) the effect of variations in the pressure on the sides of the ship due to the discontinuous motions caused by the bilge keels themselves.

(iv.) The first of these causes is sufficient in cases similar to those existing in actual ships to more than double the bilge keel resistance, and a like effect is doubtless produced by the second cause.

(v.) A considerable portion of the difference between the fourfold efficiency thus accounted for, and the still higher efficiencies found by experiment, may be attributable to other effects of discontinuous motion which are difficult to investigate mathematically. The effects here alluded to are those which depend on the changes of motion, *i.e.*, on the differences of pressure caused by the fact that the motion at each instant is not steady, but oscillatory.

(vi.) The effect of irregular disturbances, such as waves of period differing from the period of rolling, is to increase bilge keel resistance, provided that it is an even chance whether they increase or decrease the relative velocity of the liquid.

(vii.) The energy dissipated by the bilge keels is expended in setting up currents and turbulent motions in the water, such as can only be set up when sharp edges project into the fluid.

(viii.) The observed fact that motion of the ship increases bilge-keel resistance is easily explained as a consequence of the last conclusion, and is entirely in accordance with existing theories and experiments on artificial flight.

(ix.) In estimating bilge-keel resistance it will be seen that we are not concerned only with the projecting lamina called the bilge keel, but we should rather regard the whole of the part of the ship on either side of a fore-and-aft section which projects beyond a circular section, together with the attached lamina

as constituting one large effective bilge keel. This way of thinking of bilge-keel resistance makes it easier to understand the large amount of its effects.

(x.) But the presence of the projecting sharp edges is absolutely essential, for, without them, the fluid will simply flow round the rounded corners of the ship, and the whole of the dissipation of energy by discontinuous motions will be done away with.

(xi.) In fact, a ship with smoothly rounded corners to its section, without bilge keels, energy of rolling for moderate oscillations can only be dissipated by viscosity and wave formation.

(xii.) It remains a matter for experimental investigation to determine how far it still remains necessary to attribute the bilge-keel action itself to the production of water energy as a *secondary* cause, to be called into account in explaining irregularities or exceptional resistances not directly attributable to discontinuous motion.

(23) These conclusions point to the importance of attaching the bilge keels at those parts of the ship where their efficiency is a maximum. It appears, however, that existing practices pretty well fulfill this condition.

One point still remains, however, to be noticed:—It is very essential that the bilge keel should project sufficiently far to prevent the surfaces of discontinuity once thrown off from again closing round the sides of the ship, otherwise a greatly diminished resistance may be expected.

My thanks are due to Dr. Elgar, F.R.S., for his kindness in sending details relative to actual ships, which have proved of the greatest possible use in preparing this paper.

The Blue Book of American Shipping for the year 1900 has just been issued with the statistics brought down to date. It contains a large amount of information of use to ship owners, ship brokers and others who have to correspond with persons engaged in the shipping business. Among the features of the publication are lists of ship builders and owners of marine railways; dry docks in the United States; lists of U. S. naval engineers and of naval architects and marine engineers of the United States; vessel owners and mariners on the Great Lakes; officials of the U. S. Inspection Service; U. S. Courts and Lighthouse Service and other bodies having control of marine affairs. Most of the Register is occupied by an alphabetical list of American steam and sail vessels of the Great Lakes, corrected to May 15, 1900, and also of vessels in the Atlantic, Pacific and Gulf and inland rivers. There is included also a list of Canadian steam and sail vessels and of vessel owners throughout the United States. Space is also devoted to statistics of the freight trade of the Great Lakes, and lists of marine engineers engaged in service on the Lakes and in seagoing trade. A directory of steamship lines trading between the United States and foreign ports and a list of ship owners of the world are also included. There are a number of large, well-executed engravings in this issue which make a pleasant break in the accumulation of statistical matter. The Blue Book is published by the Marine Review Publishing Co., Cleveland, Ohio. The price of this work is $5.00.

U. S. Naval Shipbuilding Programme.

Before adjournment, Congress decided not to make any appropriations for further increases of our Navy. As reported in our February issue, the House Naval Appropriation Bill provided for two battleships and two armored cruisers of the most powerful types. These items in the House bill were stricken out in the Senate Committee and authorization for three submarine boats substituted. When the bill came up in conference later, the dispute was very bitter between the Senate and House conferees; Messrs. Hale, Chandler and Tillman representing the Senate, and Messrs. Foss, Dayton and Cummings, the House. The result was that all legislation for the increase of the Navy was striken out, and the Senate clause, directing the preparation of plans and specifications for two seagoing battleships and two armored cruisers, was alone left. These will be ready for Congress next December.

In previous issues we gave lists of the contractors for the new vessels already appropriated for, and since then some changes have been made, and the names of the respective vessels decided upon, so that we here publish an amended list, to date. The Secretary of the Navy has decided to omit all sheathing from battleships and cruisers. This decision was reached after the retirement of Rear Admiral Hichborn from the construction bureau, who was an earnest advocate of this system. His successor, Chief Constructor Francis T. Bowles, holds a different view regarding the efficiency of sheathing, and the board of bureau chiefs, known as the Board of Construction, recently reported unanimously against the use of sheathing for new vessels.

Following are the final awards for battleships and cruisers:

Newport News Shipbuilding and Dry Dock Co., Newport News, Va.—Battleship *Virginia;* armored cruisers *West Virginia* and *Maryland;* one protected cruiser *St. Louis* class.

Wm. Cramp & Sons, Philadelphia, Pa.—Armored cruisers *Pennsylvania* and *Colorado.*

Union Iron Works, San Francisco, Cal.—Armored cruisers *California* and *South Dakota.*

Fore River Ship & Engine Co., Quincy, Mass.—Battleships *New Jersey* and *Rhode Island.*

Moran Bros., Seattle, Wash.—Battleship *Nebraska.*

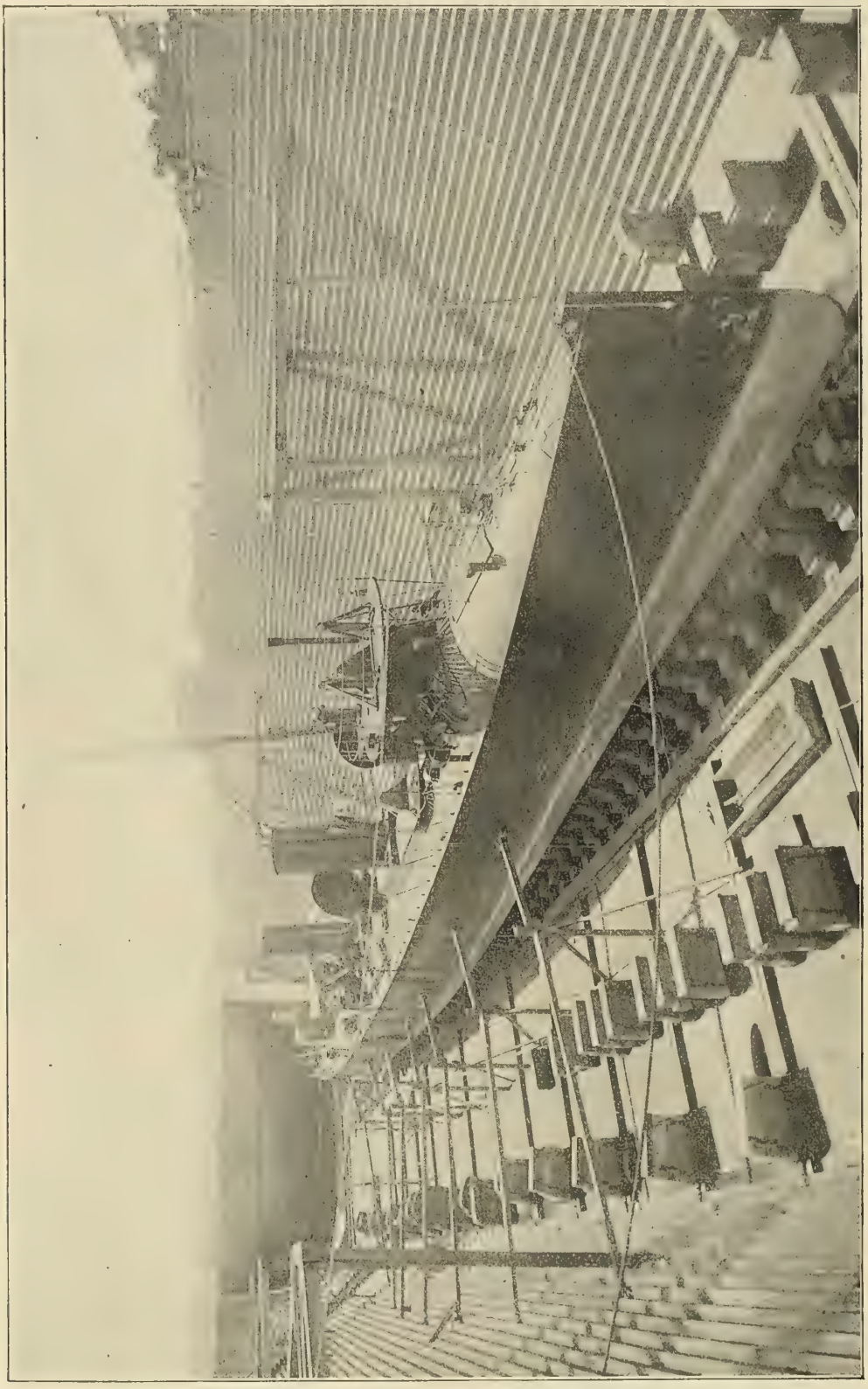
Bath Iron Works, Bath, Me.—Battleship *Georgia.*

Neafie & Levy, Philadelphia.—One protected cruiser of the *St. Louis* class.

When the proposals for the *St. Louis* class were originally opened there were several bidders, as announced in our last issue. The bid of the Newport News Co. called for certain changes in the specifications. These the Department agreed to, and one vessel each was awarded to the Newport News yard and Neafie & Levy, the same concessions being made to the latter firm, so as to put both on an equal footing. A like offer to the Bath Iron Works met with no response, and they were ruled out from competition by default. Proposals were, therefore, again issued by the Secretary of the Navy for the third protected cruiser, of the *St. Louis* class, and these will be opened in Washington, April 4. When this contract is signed all the war vessels for which appropriations have been made will be under construction.

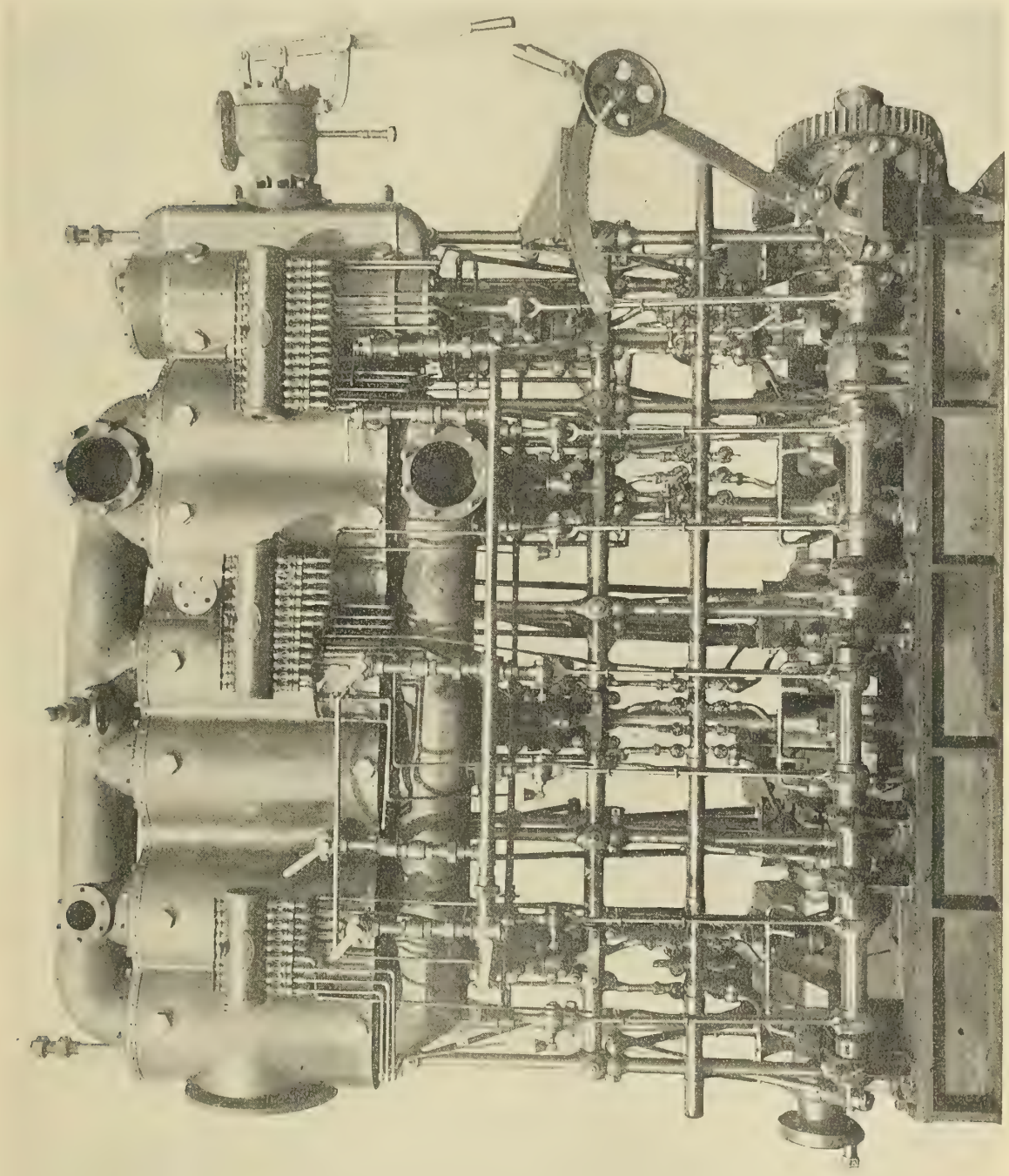
U. S. Destroyer Goldsborough.

In the accompanying reproduction of photographs we show the U. S. destroyer *Goldsborough*, and her engines—one of the three destroyers authorized by act of Congress, March 3, 1897. The contract for this boat was let in the month of July following and she was to have been ready in January, 1899. Many difficulties were encountered, however, by her builders, the Wolff & Zwicker Iron Works of Portland, Ore., in the trials, and her acceptance tests have not yet been



U. S. TORPEDO BOAT DESTROYER GOLDSBOROUGH IN DRY DOCK—BUILDERS, WOLFF & ZWICKER IRON WORKS, PORTLAND, ORE.; DISPLACEMENT, 247 TONS; I. H. P. 5,850.

completed. This vessel is of the following dimensions: Length on load line, 194 ft. 8 in.; beam, extreme, 20 ft., 5 in.; draft, mean, 5 ft.; displacement, 247 tons. She is fitted with twin screw, vertical, triple expansion, four-cylinder, four-crank engines of 5,850 I. H. P., which are expected to give her an accept-



TWIN SCREW VERTICAL TRIPLE EXPANSION FOUR CYLINDER FOUR CRANK ENGINES OF U. S. TORPEDO BOAT DESTROYER GOLDSBOROUGH.

ance speed of 30 knots. Her cylinder dimensions are: High pressure, 19 5-8 in. dia., intermediate pressure, 31 3-4 in. dia., and low pressure (2) 35 3-4 in. dia., by 20 in. stroke. She is equipped with three Thornycroft water tube boilers, having a total grate surface of 216 sq. ft. and heating surface of 13,500 sq. ft. Her total bunker capacity is 131 tons. The trials are being carried out in Puget Sound.

U. S. S. Illinois.—A builders' trial of the battleship *Illinois* was run last month off the Virginia coast. The conditions of wind and sea were favorable, but the vessel was in a very foul condition, owing to the length of time she has been in the water at the builders' yard, the Newport News Shipbuilding and Dry Dock Co. The results were exceedingly good.

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—VII.

BY CARL BUSLEY.

CHAPTER XXX.

Holland's "Holland," 1897.—The boat which the American engineer, Holland, built in 1897 is his sixth attempt in this line. His first boat was built by the Atlantic City Iron Works in New York in 1871. It was 14 1-2 ft. long, 3 ft. wide, and 2 1-2 ft. deep; it had a double bottom for water ballast, a propeller driven by a 4-horse power oil engine, and a crew of one man, who operated both the horizontal and vertical rudder. As the trials showed that this boat was entirely too small, Holland built a larger one in 1879 at the Delamater Iron Works in New York. This boat was 31 ft. long, 6 ft. maximum diameter, and 19 tons displacement. The crew consisted of two men, and it was propelled by a 15-horse power oil engine. This boat was fitted with a Zalinski dynamite gun 10 1-2 ft. long and 9 in. bore, which was intended to throw a dynamite projectile for a distance of 120 ft. through the water. At the meeting of the Institution of Naval Architects in London in the spring of 1898, Captain Jaques, in his report on the performance of this boat, spoke of the close adjustment of the air pressure in the boat, and to illustrate, in the characteristic American manner, did not hesitate to assert before that body of experts, that one day during her trials, from April to October, 1879, the boat ran her nose into the sand at the bottom so deeply that they could not back her off, and that the owner stepped out of a manhole in the bottom without a diver's dress, pulled her out of the sand and returned, and in the meanwhile not a drop of water had entered the boat. In the discussion following the reading of the paper, Mr. Barnaby, who evidently could not appreciate the joke, raised a serious question as to the possibility of such a performance.

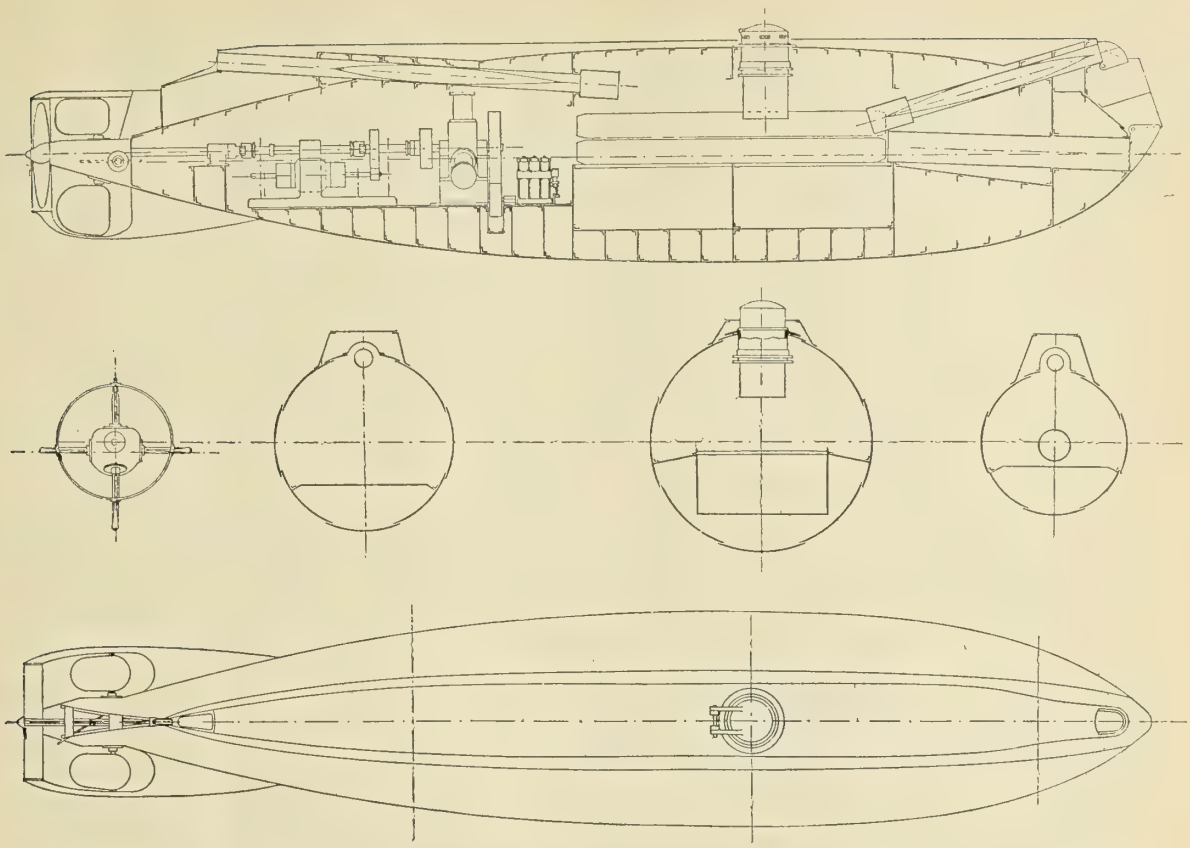
Holland's third boat, which was actually only a working model, was built in Gannon's copper shop in Jersey City. It was 16 1-2 ft. long, had a maximum diameter of 2 ft. 4 in., and a displacement of 1 ton. Its means of propulsion was to be an engine driven by powder explosions, and it was to be equipped with apparatus to study the question of horizontal steering under water. At the very first test, which was made before it was entirely finished, it sank, owing to a leak in the conning tower.

The fourth was a composite boat built at Fort Lafayette, and was intended to carry a Zalinski pneumatic dynamite gun. It was 40 ft. long and 7 ft. 11 in. maximum diameter. It was damaged while launching, poorly repaired, and thereafter used only for diving experiments in the dock.

The construction of the fifth boat, called the *Plunger*, was started in Baltimore in 1897, and is intended for the U. S. Navy. According to the report of the Secretary of the Navy for 1899 the time of completion of this boat cannot be predicted as yet. The *Plunger* is 84 ft. long, and has a maximum diameter of 11 1-2 ft. The displacement when floating light is 149 tons, when submerged 165 tons, and in the latter condition has a buoyancy of one-third of a ton, which will be counteracted by two vertical propellers, although Holland declares them to be superfluous with his system. Amidships is fitted a conning tower made of 3-8 in. material, and at the bow there are two torpedo tubes. The hull is built so strong that it can stand to be immersed to a depth of 75 ft. Water tight compartments are fitted, some of which are intended for water ballast, and some for the oil which is to be used as fuel. For sailing on the surface at light draft, a water-tube boiler of 9,850 sq. ft. of heating surface, using oil as fuel, supplies steam to two triple expansion engines, each of 600 I. H. P., which latter drive the two wing propellers, while a third engine of similar construction and developing 300 I. H. P. drives the middle propellers. The three propellers are arranged according to the system advocated by Mr. Melville. When almost totally submerged, the engines are replaced by a single 70 horse power electric motor, which can be connected to either one of the three propellers at will. The two vertical propellers are likewise driven by electric motors. The motors receive their current from storage batteries, which can be charged by a dynamo connected to either engine when the boat sails at her light draft. Compressed air is also carried on board, and is used not only for replacing the foul air, but also to force out the water ballast, and for the latter purpose there are a number of Kingston valves and pressure reducing valves. The smokestack and ventilator cowl on the deck above can be easily and quickly removed and the openings made water tight when the boat sinks to the water level.

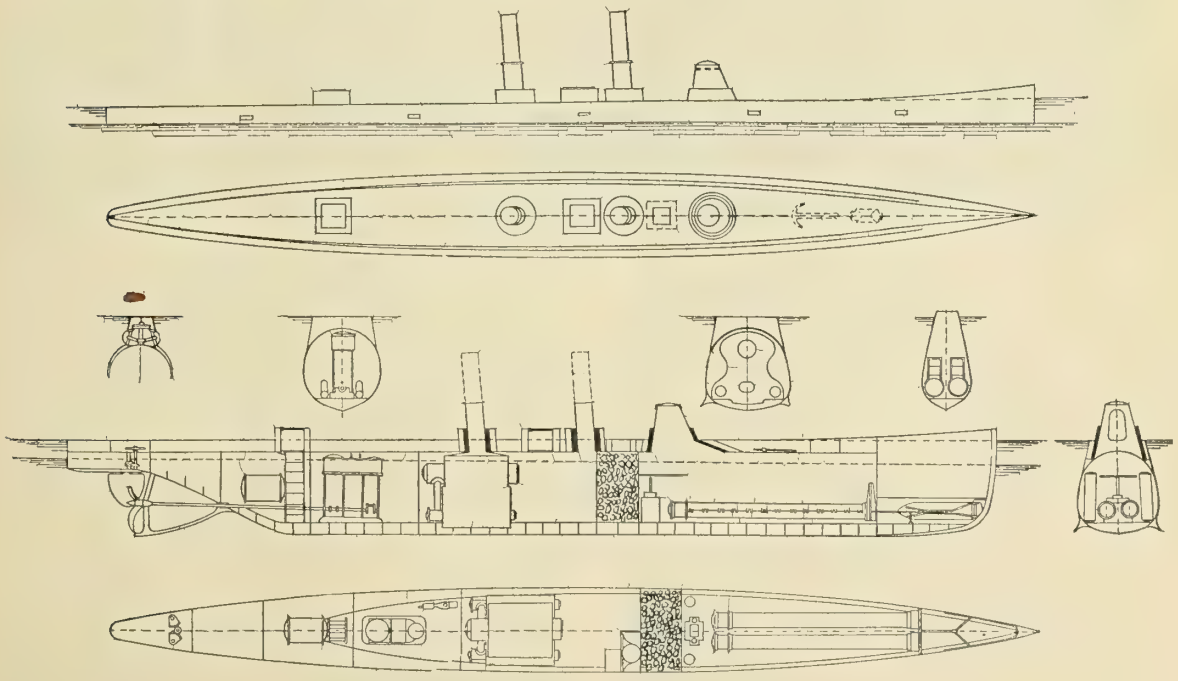
Holland's boat, No. 6, shown in Figs. 67 to 72, was built at the Crescent Shipyard in Elizabethport, N. J., according to the original ideas of Holland, while the design of the *Plunger* was considerably altered from the original by the Navy officials. This sixth boat has a length of 53 1-2 ft., a maximum diameter of 10 ft. 3 in., a displacement of 64 tons when floating light, 74 2-10 tons when submerged to the conning tower, and 74 4-10 tons when completely submerged, and a buoyancy of 2-10 of a ton under the last named condition. This boat is intended solely for the study of diving and steering under water, and therefore the question of high speed has been neglected, as it has been fitted with a gasoline engine of only 50 horse power for sailing above the surface and an electric motor of the same power and the necessary storage batteries for navigating beneath the surface. The armament consists of one torpedo tube of 18 in. bore, and two dynamite guns using powder or compressed air for propelling the projectile. The crew consists of four to six men. According to the report of Capt. Jaques the *Holland* attains a speed of eight knots at her light draft, steers well, and behaves properly when sinking or rising. Her stability is satisfactory, her means of purifying the air when submerged are reliable, and the system of filling and ejecting the water ballast is reliable. In opposition to this satisfactory report of the inventor it has been reported that during a trial under water in New York harbor in 1899 there was some derangement, and the crew did not succeed in bringing her to the surface until after the air supply had given out, with the result that they had to all be removed from the boat in a senseless condition. Another report

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.



HOLLAND'S BOAT NO. 6—FIGS. 67—72.

states that on an official trial trip on November 6, 1899, Holland sailed two miles under water, but suspicion is aroused by the fact that Holland himself designed the torpedo boat shown in Figs. 82 to 90, which, similar to its French contemporaries, is not intended for submarine work, but to sail partially submerged, and that only under circumstances not always met with in practice.



HOVGAARD'S PARTIALLY SUBMERGED BOAT—FIGS. 73–81.

CHAPTER XXXI.

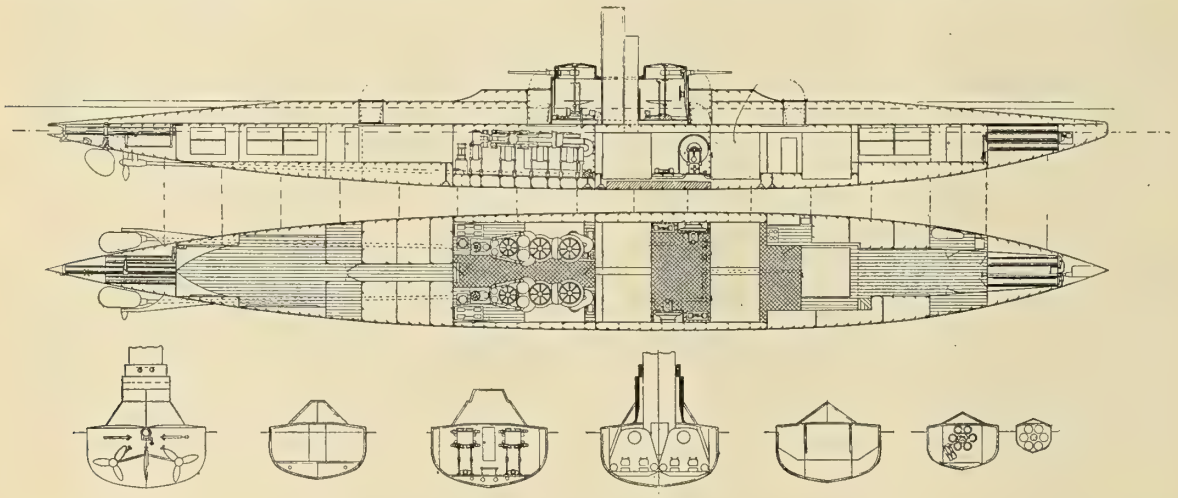
Hovgaard's Partially Submerged Torpedo Boat.—In the year 1888 Hovgaard read a paper before the Institution or Naval Architects describing a partially submerged torpedo boat which he had designed (Figs. 73 to 81). The dimensions of this boat were as follows: Length, 78 ft.; beam, 7 ft.; depth, 7 ft.; and a displacement of 57 tons when sailing at light draft with 2 ft. freeboard amidships. The motive power is to be a two cylinder compound engine of 250 indicated horse power receiving steam at 130 lb. pressure from a Thornycroft boiler. The cross bunker amidships holds 2 1-2 tons of coal, which will drive her 100 miles at maximum speed of 13 knots. The deck over the engine, boiler and steering room is to have steel plating 1 in. thick, and at her deep draft the latter will be 1 ft. under water. The conning tower is intended to be of 1 in. steel riveted plate, and this as well as the smokestack and ventilator is to have 3 in. armor plate and cofferdams. The fore peak and after peak will have a water ballast capacity of 6 tons. In addition to this there are shown a number of cellular compartments in the main body of the boat, each fitted with watertight doors, which are to be opened when requiring to sail at deep draft. When the boat sinks by letting water in the ballast tanks forward and aft, these upper compartments fill of their own accord when the doors are open, and likewise empty themselves when the ballast is pumped out. The boat is intended to float at deep draft only during attack, when the ventilator and stack is lowered so that they, as well as the tower, project only 3 ft. above the water. The last named feature would seem to be objectionable, as the boat at her deep draft could not sail at a speed any way near the 13 knots at light draft, and the exposed parts would consequently be very much exposed to the enemy's fire, in addition to the liability of the waves splashing into the lowered stack and ventilator.

CHAPTER XXXII.

Holland's Partially Submerged Torpedo Boat.—Holland's latest proposition, shown in Figs. 82 to 90, is a partially submerged torpedo boat in which the exposed parts are protected from the enemy's fire by light armor plate. He considers that such a boat would be invincible, even at the slow speed of 9 to 10 knots at light draft and 6 to 8 knots at deep draft. The prophecy which Cap't Jaques made in the spring of 1898, that this type of boat would cause a radical change in the present construction of torpedo boats and destroyers, has not materialized as yet, and the U. S. Navy, as well as the navies of other countries, are still developing their torpedo boat types on principles more generally recognized.

CHAPTER XXXIII.

Summary of the Partially Submerged Type of Boat.—With the exception of the small kind, the partially submerged boats are similar to the modern torpedo boats, even as to dimensions and displacements. In most of them electric motors are the propelling medium, causing them to be slow in speed and of a very small radius of action; some, like the *Narval* and the *Holland*, use oil engines when floating light and electric motors when under water, and latterly they are fitted with steam engines only—like the torpedo boats of Hovgaard and Holland—as they are not to be entirely submerged under any circumstance. The type in general have such a large cubic capacity that compressed air for breathing can be dispensed with. Their average speed at the deep draft is 8 knots, and at light draft 13 to 15 knots. The French boats are all fitted with the tube and mirror projecting above the surface, so that, when sailing at deep draft, the crew have this slight help in directing the course of their boats. It is still a question if this mirror, which, owing to its close proximity to the surface, gives a very small visual range, would be of any value at all when the surface is agitated by even a gentle breeze. The partially submerged boats have the advantage over those totally submerged, in the fact that they have a better fore and aft stability, but, on the other hand, when navigating in bad weather, they are said to be almost untenable for a human being.



HOLLAND'S PARTIALLY SUBMERGED BOAT—FIGS. 82-90.

Pacific Coast Shipbuilding.—In the annual report of the Chamber of Commerce of San Francisco the list of the vessels documented on the Pacific coast during 1901 is given. This shows for all classes of merchant vessels a total of 29,221 gross tons.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.*—VII.

BY LIEUT. R. H. JACKSON, U. S. N.

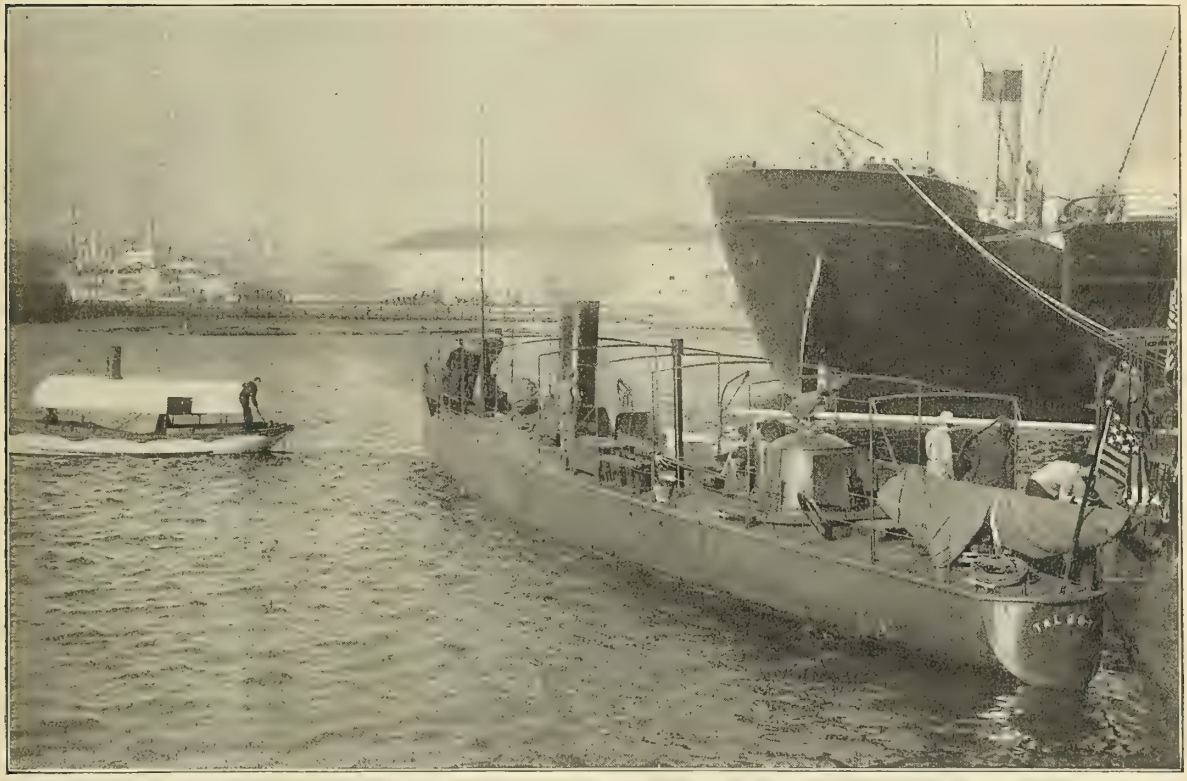
Concluding Chapter.

The following temporary increase for the time the boat was in active service, either in time of peace or war, would be much better. On boats of class R, two officers; on both class Q and class P, three officers; on the destroyers, four officers. One of these officers should always be detailed for the engine room, taking duty on deck, or excused from that according as the commanding officer saw fit. In boats having more than two officers on board this detail should be shifted after a time, say three months.

Experience on these boats, both on deck and in the engine room, is most valuable for young officers, and when the boats are called out for active service in manœuvre, etc., the supply of young officers in the junior officers' quarters of the large ships should be drawn on to fill the complement of the boats. The experience in harbor pilotage, navigation, knowledge of harbors, etc., comes to them at an age when they are quick to learn and responsibility sits lightly upon them.

Boats in Reserve.—The question has arisen: What are we to do with our boats during the time that they are not needed on active service? Two propositions are to be considered, and have been tried to a certain extent. One is to haul the boats up on a set of ways that is roofed over, and leave them there till they are needed for active work. A complete design for a large boat house, fitted with railway by which a boat can be hauled out, and a turn table so that it can be switched to a side track and another boat be hauled in, has been considered. Following out this idea, four boats were hauled out last year at the New York yard. The other proposition is to reduce the crews to the minimum needed to care for the boat, and moor the boat in a regular stall, or pen, so that no especial watch is needed to secure her safety. An officer is then placed in command of two or more of these boats, and inspects them regularly, testing the machinery at regular intervals, and taking out the boat for a run at certain intervals to insure her readiness for service at all times. When boats are kept in this manner they are actually ready for service; and by drafting the additional number of men needed for the class of service demanded of the boat, she should be ready to leave in twelve hours, or even less time. The most important men are thoroughly familiar with their duties, and can quickly instruct the others. This has been tried on some of the boats, and seems to work satisfactorily.

If the boat be on the ways, and it is desired to use her, she is put in the water, and officers and crew are ordered to her; orders are given for a dock trial, and then follows a long itemized requisition for repairs needed before the boat is ready for service; steam joints are not tight and need repacking, the condensor leaks, or the feed pump needs overhauling, or the water tanks must be cleaned out, etc., etc., and the boat does not get away from the navy yard for weeks.



U. S. SINGLE SCREW TORPEDO BOAT TALBOT—TRIAL DISPLACEMENT, 46.5 TONS; SPEED ON TRIAL, 21.15 KNOTS.

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

There is no one to blame. Time and disuse will always bring about some such condition, and then, if on top of this there has been any neglect in the precautions to preserve the boat when she was laid up, the trouble is increased many fold. A court of inquiry may follow, and, after a long search, may, or may not, find where the fault was; but this will not help the boat. She is finally hustled away from the navy yard, though her men have not yet learned all their duties. If she escapes the discomforture of an early return she will be fortunate. The new officers blame the navy yard work, and the navy yard either blames the people from whom she was received, or says that they do not know how to run her.

The two arguments in favor of hauling her out were: (1) that it was more economical, and (2) that the men were needed elsewhere.

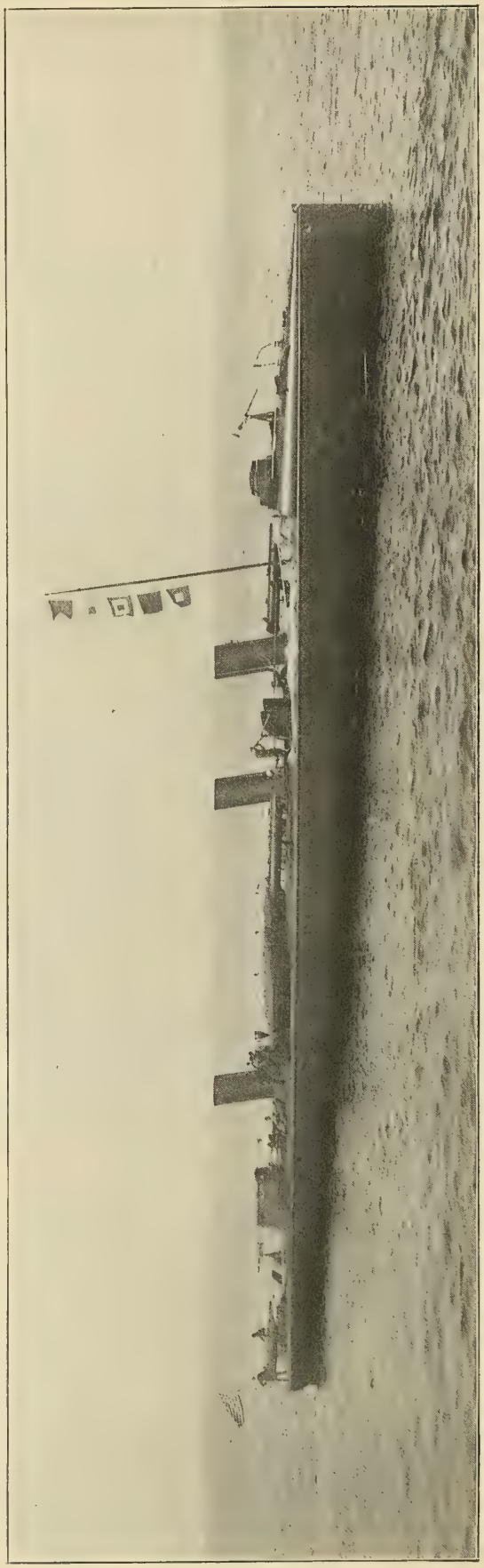
In regard to the economy, if the bill for repairs be examined after the boat has left the navy yard, it will no doubt about equal the cost of maintenance of a reserve crew on board. Moreover, if there had been a need for this boat, she could have been used at once, if kept in reserve, and can be counted on as an actual offensive power available.

In regard to the need of the men elsewhere, a detail of from six to ten men will be sufficient for each boat, so that the laying up of one big cruiser would suffice to maintain fifty torpedo boats. It is admitted that the rates of these men would run a little higher than the total of a crew of a large ship.

From the experience that has been obtained with our boats, it is thought that the following details would suffice for all boats:

A chief machinist and a machinist first class for the engine room; an oiler for each engine, one water tender for the fire room; if there be more than one boiler, an extra man in the fire room for each additional boiler. In the deck force would be needed a chief gunner's mate, a quartermaster first class, and for class P a seaman.

When these boats are in reserve they should be arranged in groups of three or four, placing, as far as possible, sister boats in the same group; a lieutenant to be placed in charge of each group. His duties would be to keep the group in running order and to take out each boat at least once a month for exercise. Target practice at full speed with torpedoes, and with the battery, to be held as often as circumstances would permit. The Navy Department requires that the former be held at least once a month, and the latter at least once a quarter. In fine weather these exercises could be held very much oftener. The boat selected to go out for practice should carry an additional crew, taken from one of the other boats, thereby giving them double the practice and lightening their duties. It is thought that the best results are undoubtedly obtained by keeping the boats in commission and requiring the men to live on board them. A man never takes the same interest in a ship or a boat unless he lives in her, nor does he form a proper sea habit. If he live in barracks on shore, the sharp contrast of his first night at sea, or his weeks at some other port than a navy yard, makes him dissatisfied and inefficient. The boats are comfortable

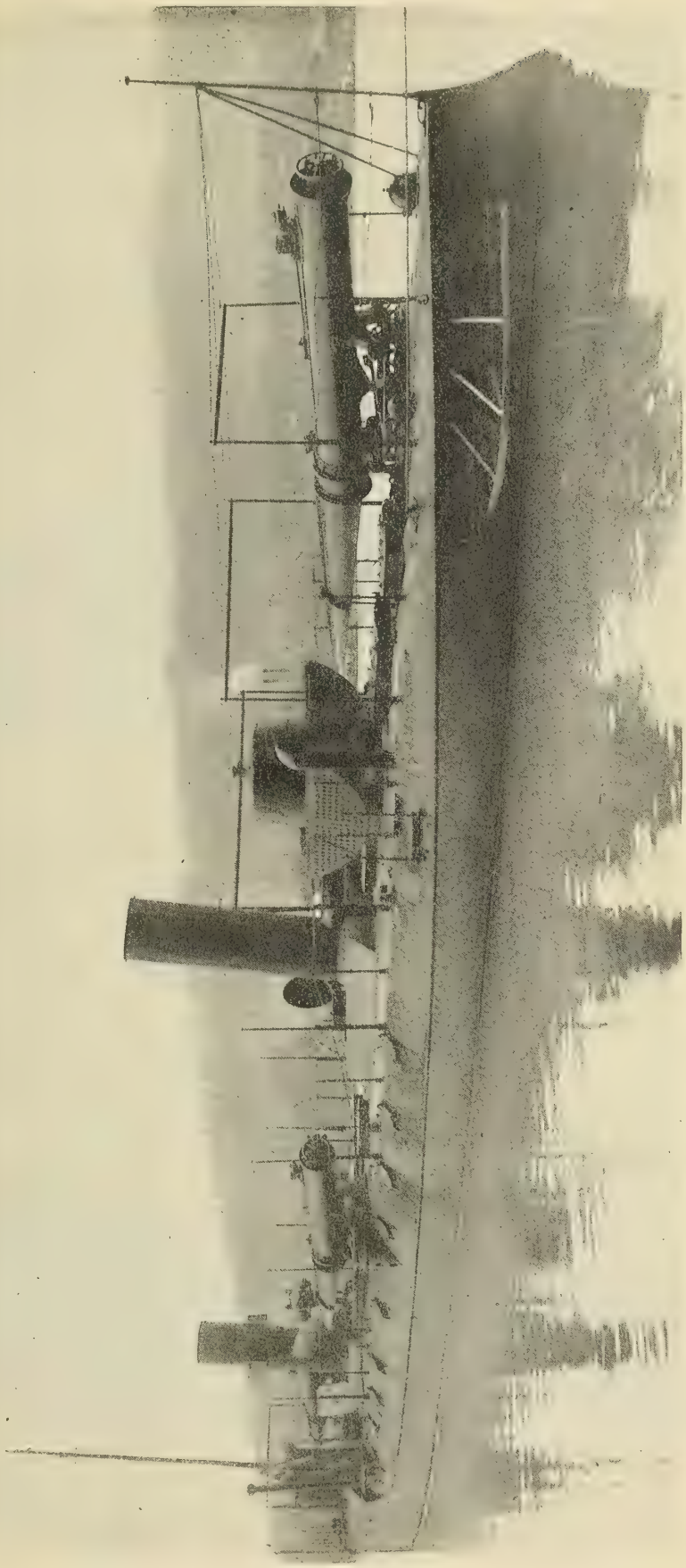


U. S. TWIN SCREW TORPEDO BOAT PORTER—TRIAL DISPLACEMENT, 165 TONS; SPEED ON TRIAL, 28.63 KNOTS.

enough when at the dock; and when at sea the man can sleep better in his accustomed bunk; in fact, is at home on board, which the barracks man is not.

Drills.—The minimum number of drills and exercises each quarter having been established, it is all important that there be an annual mobilization of this fleet at one of our important bases for a complete and thorough series of exercises in co-operation with the fleet. Newport offers the best rendezvous for battleships, cruisers and torpedo craft, while its deep water and moderate tides and land-locked covers offer fine opportunity for practice. Night attacks should be made upon the fleet while at sea, protected by destroyers, and upon single vessels in the harbor; tests as to relative visibility of different types of torpedo boats would show the value of the station boat; urgently needed training of the firemen to prevent the sudden flare from the smokestack when the near approach has begun; careful training to enable the boat to get within torpedo range with full pressure of steam, and not yet lift the safety valve. Thus a more perfect knowledge of the value of the torpedo boat will be obtained by the officers on the battle ships. The naval officer possesses the happy faculty of forgetting his anxieties and hardships; so that already the strain of the first few nights on the Santiago blockade are but faint memories. The statement is too often heard from officers who have known better that "torpedo boats don't amount to much; they did nothing during the war. We tested their attacks at Key West."

What different work would the blockade have been had we lost a battleship during the early days of the blockade by a night sortie from Santiago. There were a large number of phantom torpedo boats chased and sunk as it was, but the memory of the sudden destruction of a battleship would have made them legion.



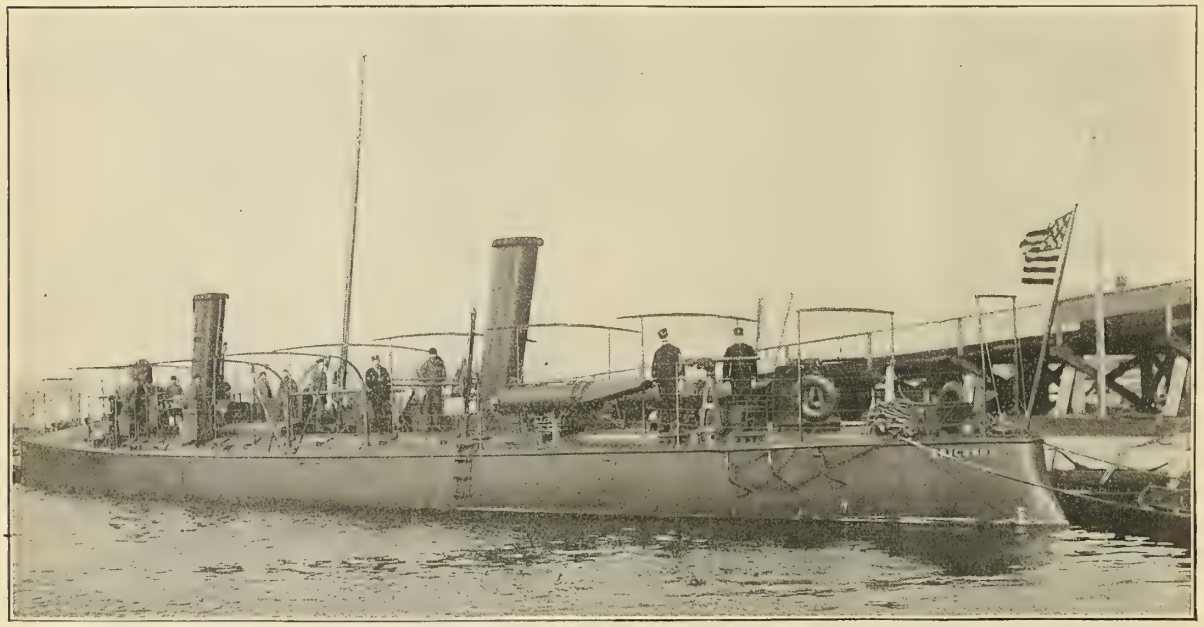
U. S. TWIN SCREW TORPEDO BOAT FOX—TRIAL DISPLACEMENT, 154 TONS; SPEED ON TRIAL, 23.13 KNOTS—BUILT ON PACIFIC COAST.

The writer does not believe that the torpedo boat can perform miracles (especially without considerable exercise and practice beforehand), but these boats have an important rôle in naval warfare, in which they have been, and will be, employed with telling, and, at times, demoralizing effect.

In conclusion, we need three types of torpedo vessels to meet the conditions which will arise in case of war,

U. S. SINGLE SCREW TORPEDO BOAT MACKENZIE, TRIAL DISPLACEMENT 65 TONS, SPEED ON TRIAL, 20.11 KNOTS.

and we need trained crews to render them efficient in time of need. The former rests in part with our national legislators; but the latter can most efficiently be maintained by keeping a nucleus on each boat, and thus keeping each boat ever ready for service.



U. S. TWIN SCREW TORPEDO BOAT ERICSSON, TRIAL DISPLACEMENT 120 TONS, SPEED ON TRIAL 21.62 KNOTS.

DESCRIPTION OF A NEW AND SIMPLE FORM OF COAL CALORIMETER.*

BY S. W. PARR.

In the study of combustibles and in all tests connected with fuels no data is of any value that does not go back to the thermal units involved. This fact itself is not new, but its application, especially in technical work, has had a marked increase in recent years. This increase has come about in spite of, rather than because of, the instruments available for the determination of heat units. It is not necessary here to

*From the Journal of the American Chemical Society.

describe the difficulties and defects connected with existing calorimeters, more than to note perhaps the two extremes; viz., the L. Thompson calorimeter on the one hand which admits of results varying by 15 per cent from the truth, and the high pressure bomb on the other which, while accurate, requires an elaboration of apparatus and skill in manipulation not conducive to the wide use it deserves.

The calorimeter here described has the advantage of operating without an oxygen gas supply; its manipulation is simple and the extraction of the heat rapid, owing to the compact mass in which the heat is generated. It is especially adapted to soft coal and while designed for technical purposes its factor of error is well within 0.5 per cent., making its results, therefore, easily comparable with those obtained by the Berthelot or Mahler bombs. The principle involved in the process depends upon the liberation of oxygen from such a compound or chemical as shall in turn absorb the products of combustion, thereby avoiding the necessity of providing conduits for the gases. A chemical which admirably meets these requirements is sodium peroxide. Its operation may be illustrated by the following experiment, which was one of the first used to determine the adaptability of this chemical. A sample of combustible and sodium peroxide in suitable proportion were placed in a short, heavy, copper tube with close-fitting screw plugs at each end and the contents thoroughly mixed by shaking. The bomb was then held in the flame of a Bunsen burner till ignition was effected. Upon cooling and opening it was found that no pressure of gas was present, and on dissolving out the fused mass the combustion was shown to be complete. The instrument ultimately employed for utilizing these conditions may be best shown by an outline sketch.

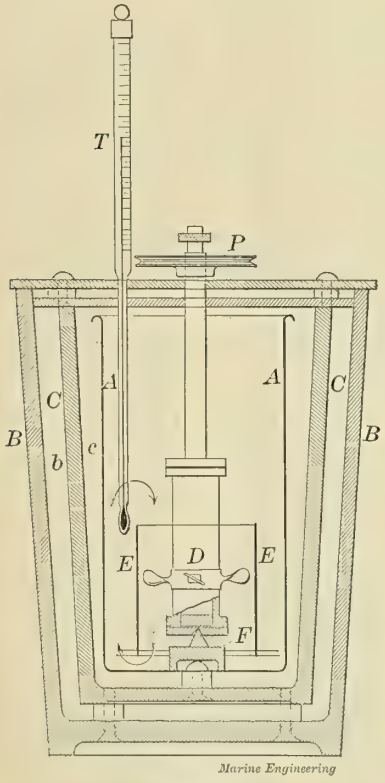


FIG. 1.

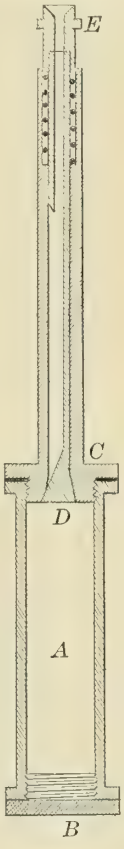


FIG. 2.

A (Fig. 1) is a copper vessel of a little over two liters' capacity, insulated by two outer vessels of indurated fiber, *B* and *C*, so placed as to provide further insulation by the air spaces *b* and *c*. The cover is double to correspond with an air space between, the two parts being connected for convenience in handling. The cartridge *D* has an inside capacity of about 25 cc. It rests on a pivot below and extends through the covers above, and has a small removable pulley at the end. Turbine wings fastened to spring clips are placed on the cartridge, and a short cylinder *E*, open at both ends, is provided for directing the current set up by rotation of the vanes attached to the cartridge. The vanes are so set as to deflect the currents downward, first along the cartridge, and then up along the outside of the cylinder. The stem *G* of the cartridge is so arranged as to permit the passage of a short piece of No. 12 copper wire (Fig. 2). It is, moreover, provided with a valve *D* at the lower end, which prevents the escape of the enclosed air when heated by the combustion of the charge. The two ends *B* and *C* of the cartridge screw on. The process then is as follows: 1 gram of coal ground to pass through a 100-mesh sieve and dried in the oven as usual at 105-110 deg. is put into the cartridge, 16 to 18 grams of sodium peroxide are added, the top screwed on and the whole shaken to thoroughly mix the contents. The peroxide varies somewhat in fineness. It should practically all pass through a 25-mesh or 1-mm. sieve After tapping the cartridge to settle the charge in the bottom, it is placed in a can and two liters of water added, the temperature of the water being 3 or 4 deg. lower than the temperature of the work room. The pulley is connected by string to a small water or electrical motor giving about 50 to 100 revolutions per minute to the cartridge. When constant temperature is reached, the reading of the thermometer is taken, and the hot wire is dropped through the valve into the charge, which is at once ignited and burns completely in two or three seconds. The extraction of the heat is effected in about five minutes. The reading of the maximum temperature is taken and the calculations made, as follows:

First.—A correction factor is needed for the hot wire. The average of many determinations on various lengths up to 2 in. establishes a fairly uniform factor of 0.012 deg. C. or 0.021 deg. F. per 1-2 in. of No. 12 copper wire. In this work the lengths used have been 1-4 in. and 3-8 in. and the correction factor for the wire has been 0.006 deg. and 0.009 deg.

Second.—A correction is made necessary by reason of the heat resulting from the combination of the products of combustion, carbon dioxide and water, with the chemical employed. This heat of combination causes an excess over and above the actual heat of combustion, amounting to 27 per cent of the total indicated heat. Hence, this correction must also be applied in the calculation. The method then of calculation will be as follows: Supposing a centigrade scale to have been used, if *C'* represents the total indicated calories, *C* the actual calories due to combustion.

t the rise in temperature, and w the water employed, then $C' = (t - 0.012°) \times w$,

and $C = C' - \frac{C' \times 27}{100}$,

or $C = (t - 0.012°) \times w \times 0.73$.

In case a Fahrenheit thermometer is used the temperature of correction for 1-2 in. of wire is 0.021 deg. instead of 0.012 deg., and the final result is B. T. U. per pound of coal instead of calories. Of course, with a centigrade thermometer the ultimate reading is changed from calories to B. T. U. by multiplying the calories obtained by 1.8.

A word of explanation is necessary as to the method of arriving at the factor for the heat of absorption of the products of combustion. The two elements concerned are carbon and hydrogen. For the carbon dioxide resulting from the combustion of the former, the correction factor is easily determined. Pure sugar carbon is prepared and run in the calorimeter as above described. The average of a number of such determinations gave a total calorific result of 11,084. Now, taking as the accepted figure for the heat of combustion of carbon in calories, 8,080, we have therefore an increase of 3,004 calories due to the heat of absorption of the carbon dioxide by the chemical. By computation this is found to be 27.1 per cent of the total indicated heat. Now as to the heat due to the absorption of water from the combustion of hydrogen, the problem is not so simple. The burning of sugar affords no indication, for seemingly other compounds than water are formed, and as in the case of sugar, burned in the bomb calorimeter, while the results are constant and repeat themselves with exactness, they vary so widely from the theoretical data as to make it evident that the combinations do not proceed in a simple manner. Naphthalene does not afford a factor, chiefly owing to its volatility and consequent faulty combustion. The liberation of a known weight of water in the interior of the cartridge gave very indifferent results, the water not disseminating throughout the peroxide, but incrusting itself in a moist mass. Many other methods were tried, with the result that so far at least it has been necessary to fall back on empirical data obtained from burning widely different varieties of coals and checking the same coals by combustion in standard bomb calorimeters. The table on this page gives the results thus obtained, using coals varying in their ash content from 3 to 32 per cent, and in water from 1 to 14 per cent. Also as wide a variation in the character of their hydrocarbons as possible, using a cannel coal—Pennsylvania gas coal, a lignite and soft coals from widely separated districts in Illinois.

Supposing the factor for absorption of water formed from a given weight of hydrogen to be approximately the same per cent of total heat evolved as in the case of carbon dioxide, viz., 27 per cent, and applying this factor throughout, we have the following results obtained by running parallel combustions in a standard Atwater or Mahler bomb calorimeter and the sodium peroxide appartus. In a number of samples the process was conducted in both the Atwater and Mahler bombs. The instruments, however, checked so closely that this practice was not continued throughout the tests. The proximate analysis is included in the table in order that the wide variations in the character of the coals may be indicated (see table).

A few facts should be noted:

(*a*) It has been discovered after most tedious experience that a comparison of calorimeters should be made at approximately the same time. For example, a series of calorific determinations made on finely ground samples on May 12, 1900, were found to give a reading 2.4 per cent less on July 12, 1900. It was necessary to repeat practically all the above determinations on this account, all results showing a slow deterioration in the finely ground samples. This subject will receive further attention later.

(*b*) In the table it should be noted that the first five samples are from the same mine, and vary but slightly in composition. The particular purpose in introducing this series was to note if the calorimeter would differentiate between such small variations in the inert material, the ash and water.

Tabulating the results with reference to these inert materials and giving simply the calorimetric reading for each, we have:

	Total of water and ash.	
No.	Per cent.	B. T. U.
216	13.79	12,214
217	11.80	12,286
218	9.87	12,924
220	11.45	12,345
221	14.02	12,056

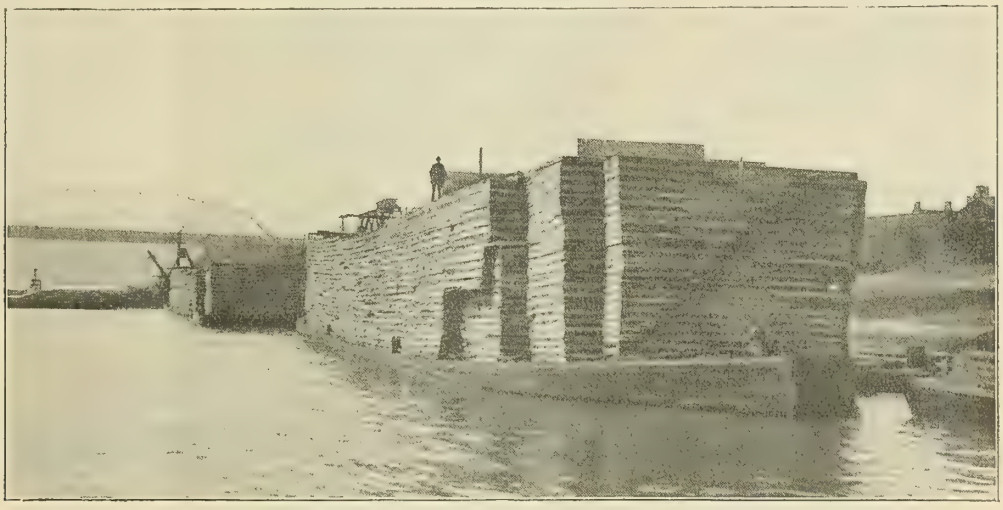
COMPARATIVE TABLE SHOWING RESULTS OBTAINED WITH NEW AND OLD FORMS OF CALORIMETER.

Kind of Coal.	Proximate Analysis. Moisture.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	B. T. U. per lb. air-dried coal. Bomb calorimeter.	New method.	Variation from standard bomb in per cent.
216 Carterville, Ill., mine run	4.87	34.11	52.17	8.85	0.85	12,205	12,214	+0.07
217 Carterville, Ill., washed No. 1	4.66	33.99	54.21	7.14	0.74	12,289	12,286	0.00
218 Carterville, Ill., washed No. 2	4.31	35.12	55.01	5.56	0.87	12,914	12,934	+0.08
220 Carterville, Ill., washed No. 4	4 86	33 26	55.29	6.59	1.15	12,355	12,345	—0.08
221 Carterville, Ill., dust from washer	5.50	32.97	53.01	8.52	1.16	12,384	12,336	—0.39
226 Odin, Ill., pea coal	7.27	35.76	42.96	14.01	3.89	11,025	11,064	+0.35
227 Farmington, Ill., mine run	11.22	35.93	36.60	16.25	3.98	9,986	10,018	+0.32
228 Pennsylvania gas coal	0.92	36.66	58.94	3.46	1.40	14,270	14,275	0.00
229 Kentucky cannel coal	0.99	32.33	34.35	32.33	1.07	10,313	10,328	+0.14
230 Mississippi lignite	14 56	43.82	29.30	12.32	....	8,316	8,378	+0.74

(*c*) It has already been mentioned, but attention should again be called to the fact that with the calorimeter it is necessary to operate on the oven-dried sample for the reason that the water, if left in the sameple, gives off heat in combining with the chemical; hence, a gram sample is weighed and dried in the oven, or if the per cent of moisture is known, an oven-dried sample may be weighed out, making allowance for the water. No other conditions vary the results. About 17 times the weight of coal is the best amount of peroxide to insure complete combustion, but variations from 16 to 20 times the amount do not appreciably vary the results. Indeed, with careful work and a good thermometer the instrument repeats its own results fully as closely as the bomb calorimeters. The usual practice, moreover, has been to work with half-gram samples, using a measured quantity—8 to 9 grams of peroxide. With a suitable room and reasonable precautions as to temperature of both room and water employed, exceedingly constant and satisfactory results may be obtained, which should vary less than 0.5 per cent from the best figure obtainable with a standard instrument.

Model Ohio River Barge.

In the photograph there is shown one of the great lumber barges used on the Ohio River. This boat loaded carries 1,335,000 ft. of lumber, and is rated as of 2,000 tons capacity. Her dimensions are: Length, 225 ft.; beam, 41 ft.; depth, 8 ft. hold. She is built of wood and the principal dimensions of scantlings are as follows: Bottom, 3 1-2 and 4 in.; knuckle, 4 1-2 in.; sides, 3 1-2 in. and 3 in.; deck clamps, 3 in. by 12 in. and 2 1-2 in. by 10 in.; futtock bed, 6 in. by 6 in.; futtock top, 3 in. by 8 in.; side clamps, 3 in. by 8 in.; pointer streaks, 3 in. by 8 in., running clear through; deck 2 1-2 in. The main kelson is 8 in. by 12 in. with a 4-in. solid bulkhead bolted on top and extending to the deck framing. The value of the barge is $14,000. It was built by David Barnes, of Madison, Ind., for John Barrett & Son, Cincinnati, Ohio, and is named the *Slack Barrett*.



OHIO RIVER BARGE SLACK BARRETT LOADED WITH 1,335,000 FEET OF LUMBER.

SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

Facilities for Study at the Royal Technical High School, Berlin, Germany.

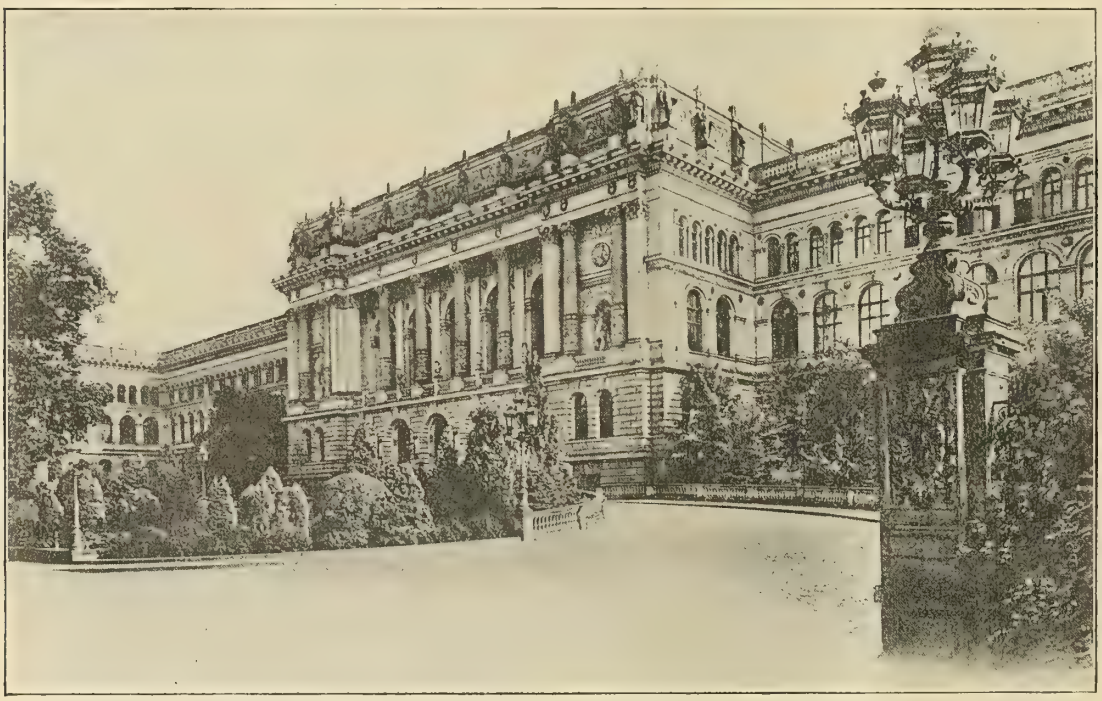
BY GEORGE CROUSE COOK.

The history of the Royal Technical High School, which celebrated its one hundredth anniversary under the patronage of Kaiser Wilhelm II and members of the German nobility, in October, 1899, begins with the foundation of a "Bauakademie" at Berlin in 1799, during the reign of Friedrich Wilhelm III, King of Prussia. This school, which had courses of instruction in general architecture and bridge construction, was carried on independently until 1879, when it was joined with a Berlin school of engineering and chemistry known as the "Königliche Gewerbeakademie" and the term Royal Technical High School applied to the consolidation. The high school was continued in the buildings of the "Bau- and Gewerbeakademie" until 1885, when the whole was transferred to a new building especially designed and constructed for this technical work. This building of the high school occupies an excellent site in the Berlin suburb known as Charlottenburg, on a continuation of the renown broad avenue of shops, the "Unter den Linden," and at a distance of about two miles from the Royal palace. It is a broad, imposing, three story stone structure, arranged for the accommodation of 2,000 students in the classes. In the rapid development of the school, however, in all its departments, it is now overcrowded and a number of additional buildings are being erected in the surrounding grounds for the work of particular departments, while a proposition is under consideration to add a fourth story to the central building and install elevators. Each building and each section of the main building possesses all conveniences for facilitating scientific work that experience and foresight could suggest.

There are at present fully developed departments in architecture, constructing engineering, machine con-

struction, ship and marine engine building, chemistry and mining, and for abstract scientific investigation. The scope of these departments can in no way be better shown than by the statement that they employ the services of eighty-five professors, sixty-four instructors and teachers of foreign languages, four practical engineers and 256 assistant instructors. On the opening of the 1900 summer session at the high school there were 2,686 regular students and 319 new students enrolled, and in addition there were 872 students for special work and from foreign countries. The foreign students, of whom there were 262, came from about twenty-six different countries, while all the continents excepting Africa were represented.

The management of the high school, which is supported by the German government, is nominally in the hands of the State Minister of Education, but so high is the confidence placed in the high school Senate, com-



BUILDING OF THE ROYAL TECHNICAL HIGH SCHOOL AT BERLIN, GERMANY.

posed of twelve of the senior professors, that its action in relation to the student life is final, and it is to this body that a foreign candidate for admission to the classes must present his certificate of proficiency in preparatory work.

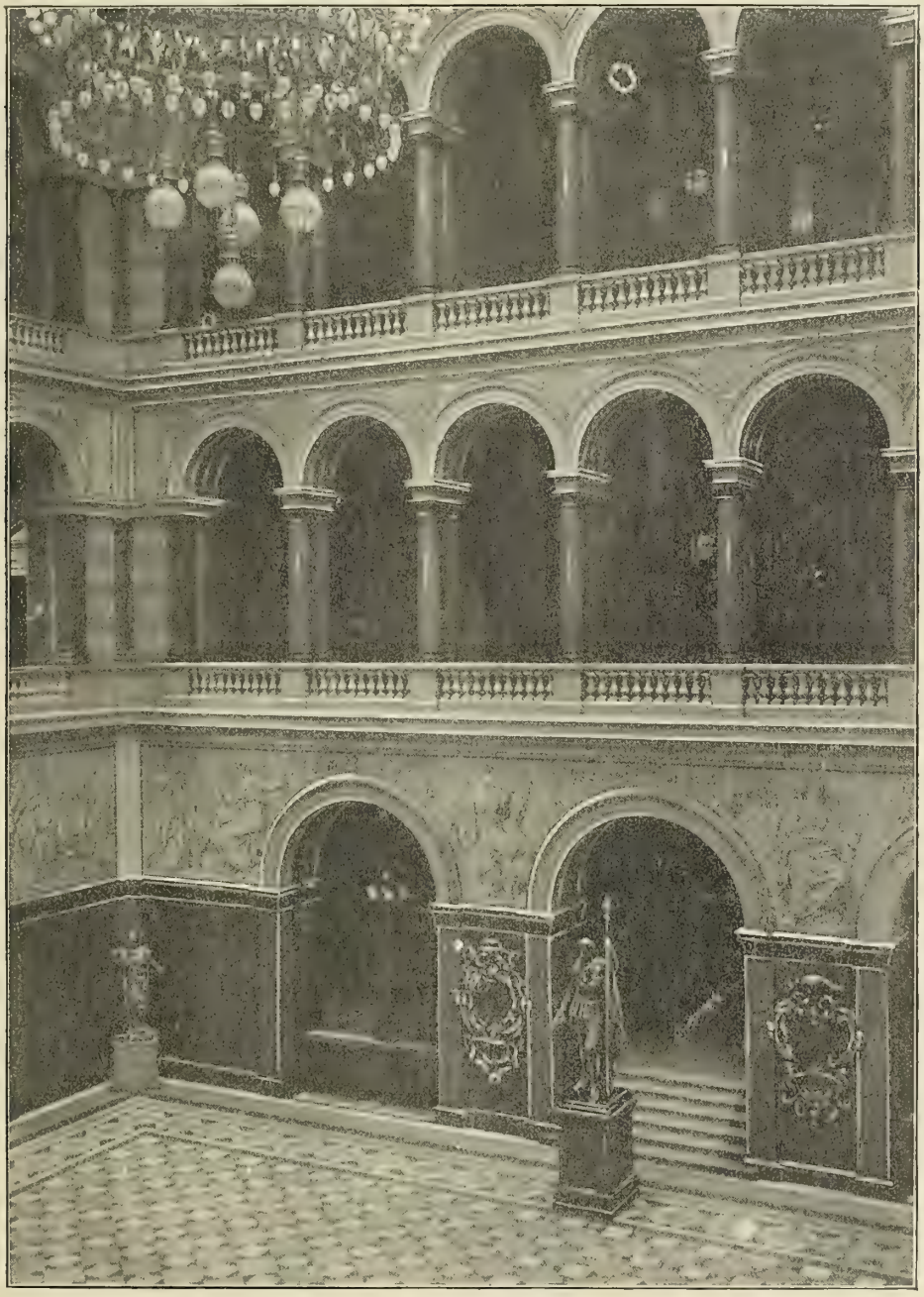
The department of ship and marine engine building is the development of a "section for ship building," established in 1860, of the engineering department of the "Gewerbeakademie." It was continued as a branch of this department until 1894, when the number of students and steadily increasing interest in the topic warranted its establishment as an independent course. The department occupies an excellent section on the second floor of the main building, consisting of seven well lighted and ventilated drawing rooms and a number of offices and lecture rooms. The drawing rooms are fitted with tables, cabinets for drawings, and coat lockers, so that each student has an independent working place and store. The artificial lighting is very good, each table being supplied with four lights, two stationary gas lamps, which hang from the ceiling, and two portable incandescent electric lamps on stands. All of the rooms are supplied with many good battens and batten weights and the conventional calculating machines. Each student, however, is expected to be supplied with drawing instruments, a set of ship curves and all necessary paper, pencils and inks. The walls of these rooms are decorated with photographs of ships of all types and periods, half models and finished drawings worked up by former students, while in the long, broad halls stand many excellent ship and engine models presented by builders and others interested in the school. The lecture rooms associated with the department are of the conventional type, the lecturer's desks and blackboard being the center of a series of benches of semi-circular form and increasing elevation. Over these rooms on the third floor is a mold loft of fairly good dimensions, where line drafts worked up by the students are laid down in full size.

The complete course in ship and marine engine building, taken by a regular student entering the high school after graduation from a gymnasium or German preparatory school, and spending six or twelve months as "volunteer handworker" in a shipyard or machine shop, extends over a period of four years. Each school year is divided into two sessions, the first, termed the "Winter Half Year," extends from the middle of October to Easter, with a two weeks' vacation at Christmas, and the second, or "Summer Half Year," begins about the middle of April and holds to the first of August.

The first two sessions, with the exception of a few hours each week for ship drawing, are devoted to such

general scientific study as physics, chemistry, higher mathematics, etc. In the third and fourth sessions, while the general science work predominates, special lectures are introduced which explain and illustrate by sketches the arrangement of shipyards, the elemental principles of ship design and construction, the simple arithmetical ship calculations and also the elements of the marine boiler. The student is required to demonstrate his familiarity with the subjects of the special lectures by actual practical work in the drawing room, and this work is counted in the "Preliminary Examination." This, however, is mainly a scientific examination, and takes place at the end of the fourth session, and the students in attendance must qualify to continue the work of the course.

With the beginning of the fifth session the special branches take the predominating part, which they hold to the end of the course. The lectures in practical shipbuilding continue from the point reached at the end of the previous session and explain and illustrate, by sketches, additional details of hull construction, the ship's equipment, ventilation, drainage, etc., and the empirical regulations of the registration societies on freeboard, water tight subdivision and general measurement. The theoretical work treated and illustrated in the lectures given along with these practical topics embrace the dis-



INTERIOR COURT OF ROYAL TECHNICAL HIGH SCHOOL BUILDING AT BERLIN.

placement calculations, the longitudinal and transverse stability calculations, the laws of resistance, the power required to overcome this resistance, the efficiency of the various modes of propulsion and their effect on resistance, the laws of pitching and rolling, the theory of wave formation and the sources of vibration in a ship's hull. These are first treated in a general manner and then applied to specific forms under special conditions, as the sail area of maximum efficiency for a given ship, the stability of a steamer among waves and the effect of free water in a ship's hold. Lectures are also given at this time on the general design of the steam engine. Nearly one-half of the time in these two sessions of the third year is given to drawing room work, which is based upon the topics and sketches of the lectures. The student is first required to prepare a line draft for a cargo vessel of given dimensions, possessing a required displacement, and then to calculate the curves of its form. On completion of the first exercise the student begins plans for a cargo passenger steamer. These are based upon the lectures and sketches given and actual practical data placed in the drawing room, and result in a design which fulfills required conditions as to passenger and cargo capacity, radius of service at given speed and midship section as specified by one of the registration societies. The lines of this vessel are then laid out in full size on the mold loft floor and faired up by water lines, buttocks and diagonals. A small wooden half model is also made and the plating is laid off and forms for material orders are gotten out. The drawing room work required during this year from the student specializing in marine engineering is the preparation of complete plans for a cylindrical boiler, a locomotive boiler and a water tube boiler.

From the opening of the seventh session, which is the beginning of the last year, the ship and marine engine branches advance on even more independent lines, there being no more work common to both. The shipbuilding course, while touching the subject of ship machinery and calling for experimental work with shipbuilding materials in the laboratory, is practically wholly taken up by the exhaustive detailed investigation of the work already specified. The subject of construction is treated most thoroughly and practically by the introduction of builders' plans showing the highest modern practice. The drawing room work requires: The general arrangement of the engines of a given ship; familiarity with the conditions to be met in the installation of the propelling machinery and its auxiliaries; a complete set of merchant ship plans consisting of the general arrangement, midship section, stem and stern, shell expansion, deck plating, and, in fact, all such plans as would be necessary for the actual building of the hull; and in addition to this the general arrangement of a war vessel is required. During this period the marine engine student goes through a special electro-technical course, which is merely touched by the shipbuilding student, and must prepare the building plans for a marine engine, including the auxiliaries, shafting and propeller.

All regular German students who have qualified in the "Preliminary Examination" and have continued the work of the high school to the end of the eighth session may now become candidates at the government examinations for a commission to the lowest rank in the German naval construction corps, a body which has the duties though not the rank of the members of United States construction corps. German students who may not care to enter the naval service, or foreigners who have passed through the same prescribed course, may become candidates at the high school "Diploma Examination." On qualifying in this, and being awarded the "diploma," the graduate possesses the highest technical certificate to be won in the German State and, if he so desires, may be immediately absorbed by one of the great German shipyards.

Any person speaking and writing the German language and at least seventeen years of age, though from a foreign country, who presents papers which satisfy the board of instructors of his proficiency in the work of the first two years of the regular course, is permitted to try the "Preliminary Examination." By qualifying he is allowed to take up the course at this point and become a candidate at the "Diploma Examination" on completing the intervening studies. Again, any person not intending to enter for the diploma, but who satisfies the professors that he has had a sufficient grounding in mathematics, physics and drafting to attend the lectures with intelligence and perform the drawing room exercises with reasonable efficiency, is accepted as a student and may follow the work of the third and fourth years. All students who are not regularly entered by the qualifying examinations or certificates are known as "hospitants," and, while allowed the same privileges and liberties as the regular student, are called upon to pay a twenty-five per cent greater fee, which is originally, due to government support, merely nominal.

One of the most satisfactory qualities of the entire course is its direct practicability; drawings are made which show superior draftsmanship than those of the average shipyard drawing office, and which are as complete and accurate in all details as actual building plans; calculations are made on plans of recently constructed ships, and their accuracy checked by comparison with the builder's work, which is freely supplied and placed before the students.

The course of instruction in this department is in the hands of five professors and a number of assistants, all of whom have been selected from stations giving the highest experience in the work under their charge. Lectures and drawing room instruction in naval hull construction are given by a retired German naval constructor, while a second ex-naval constructor treats of the man-o'-war arrangement, disposition of guns, magazines, boats, etc.; a third professor has charge of the practical features of general ship and boat building, and the whole field of theoretical naval architecture and merchant ship design, is taken by Professor Oswald Flamm. All lectures and drawing room directions for the students of marine engine building are given by Professor Gorris, who, previous to his occupation of this chair was one of the directors of the German naval engineering bureau.

Of these members of the faculty Professor Flamm alone holds his appointment directly from the State Minister of Education, and in consideration of this fact and his attainments he is the recognized leader of the

DRAWING ROOM IN SHIP AND MARINE ENGINE BUILDING DEPARTMENT OF ROYAL TECHNICAL HIGH SCHOOL.

CLASS AND RECITATION ROOM FOR MARINE STUDENTS AT ROYAL TECHNICAL HIGH SCHOOL IN BERLIN.

department. After his graduation from the high school in 1887 he served as draftsman in two small German shipyards and then entered the office of Blohm & Voss, shipbuilders of Hamburg, where he acted as leading draftsman and designer on proposals. In 1892 arrangements had been made to place the management of a small Hamburg yard in his hands, when he was offered the position of State professor of theoretical naval architecture at the high school. Under his management and direction the department first became independent and then grew and developed so that in the session just completed there were 220 regular students enrolled in the classes.

Professor Flamm is a leading member and contributor to the literature of the newly founded German society of naval architects, and he is also a member of the famous society of German engineers. He is a member of the Imperial Naval Examination Board for the officers of the construction corps, and has been recently appointed the director of the Naval Museum to be established at the high school.

The writer desires to acknowledge his indebtedness to Captain William Buhler, U. S. N., naval attache to the U. S. Embassy at Berlin, for his courteous assistance in the preparation of this article.

Motor Boat Neptune.

Our engraving shows the motor boat *Neptune*, fitted with a 16 horse power Olds marine gasoline engine. This boat has a maximum speed of 12 miles an hour. One feature of the Olds motor, for which the makers claim distinction, is that each engine is rated at less horse power than it will give out in practice. An engine rated as 4 horse power has two cylinders each 4 1-2 in. by 6 in., and a 6 horse power engine has also

OLDS MOTOR BOAT NEPTUNE.

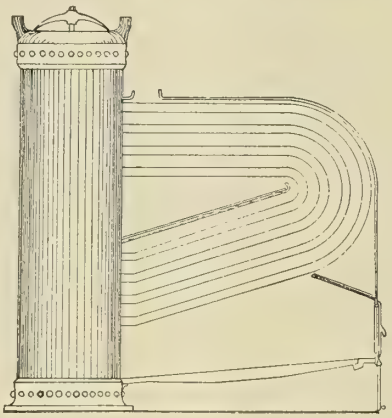
twin cylinders, 5 1-2 in. by 8 1-4 in. stroke. With this form of motor a solid wheel is used, and in the launches built by the company great care is taken to have the propeller suited exactly to the form of the boat and other controlling conditions. The engines are built on the four cycle principle and the exhaust is in all cases carried under water, thus getting rid of a disagreeable nuisance.

In the *Army and Navy Journal* of March 23 there is a very interesting letter and editorial concerning Ericsson's *Monitor* and the difficulties that inventor met with before the success of his ship was demonstrated.

IMPROVED APPARATUS.

New Water Tube Boiler.

A new form of water tube boiler is shown in the accompanying drawing. This consists of a drum, stood on end, into which are expanded the generating tubes. The lower row of tubes forms the furnace crown and a baffle plate placed inside the innermost coil of tubes causes the gases to pass over all the tube surface on their way to the smoke pipe. A manhole in the top

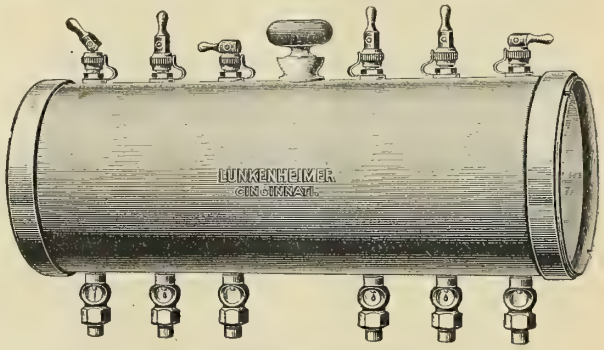


BUGBEE & LAYCOCK BOILERS.

of the vertical drum permits of inspection and repair. It is claimed for this boiler that the circulation is very rapid, as there are no small bends or manifolds to interrupt the course of the flow. It has been approved by the U. S. Board of Steamboat Inspectors and is manufactured for sale by Bugbee & Laycock, 130 South Clinton street, Chicago.

Multiple Engine Oiler.

With modern fast-running engines a steady flow of lubricant is in many places a necessity. To effect this when the engine is running, and prevent waste when stopped, has led extensively to the adoption of reservoirs. The style of oiler shown in the engraving con-



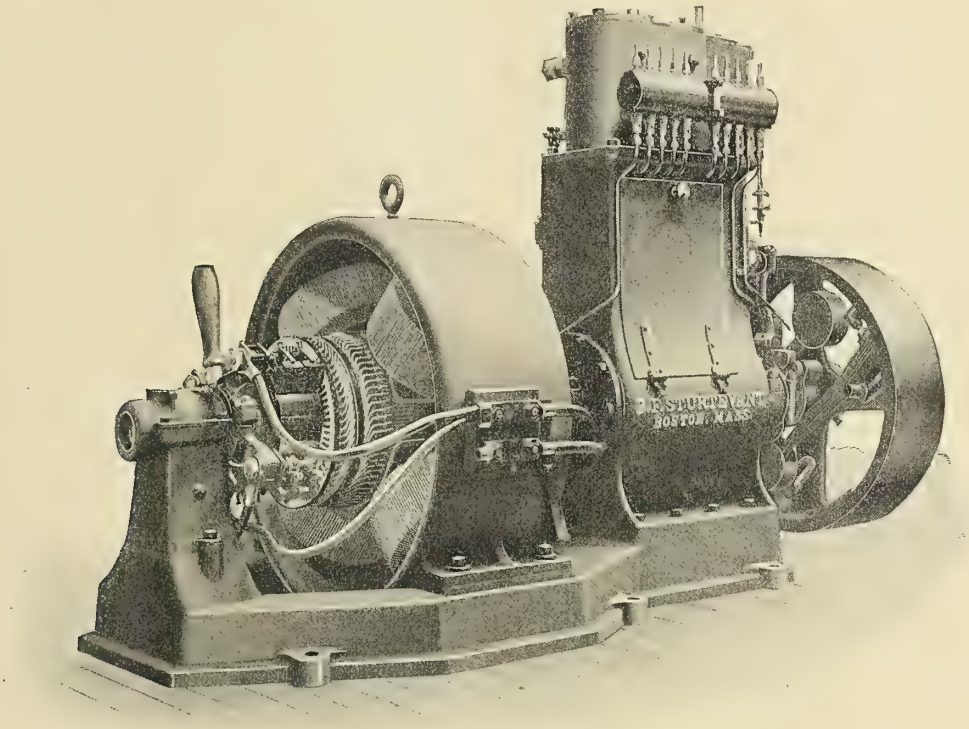
LUNKENHEIMER MULTIPLE OILER.

centrates the supply for a number of bearings in one receptacle. As shown, sight feeds are provided, so that the constancy of flow can be readily noted. The rate of flow is regulated by screwing up or down the milled regulating nut on top and raising the snap lever. This device is stocked in several sizes and is fitted

with unions threaded inside or out, or with plain ends for brazing. It is manufactured by The Lunkenheimer Co., Cincinnati, Ohio.

Sturtevant Lighting Set.

A new line of ship lighting sets has been put on the market by the B. F. Sturtevant Co., of Boston, Mass., and one of these is shown in the accompanying engraving of a 5 in. by 4 in. enclosed double upright engine with a standard 12 kw. 4 pole generator. The engine is of the type originally designed for the severe work of forced draft fan propulsion on the vessels of the U. S. Navy. The cylinders are placed side by side in the same casting; the cranks are set opposite. Steam being admitted simultaneously to the top of one cylinder and the bottom of the other, the reciprocating parts are balanced in their movements and high speed is made possible. The cylinders are of large diameter as compared with the stroke, so that great power may be developed at high rotative but moderate piston speed, making the engine particularly suitable for direct connected dynamo driving. The steam admission to both cylinders is regulated by a single piston valve, under the control of a shaft governor of the same design as that used upon the single upright engines. All moving parts subject to friction are of steel and the bearings of ample size. Automatic relief valves are provided to prevent any danger of damage by water in the cylinder. Complete sight feed oiling arrangements from a single oil tank connect with all of the bearings, and the frame is so constructed as to readily and entirely enclose all running parts, while still leaving them perfectly accessible by the mere opening of the door. The magnet frame of the generator is of cast steel, and the shaping of the pole pieces and proportioning of magnetic field and armature is such as to insure absolutely sparkless operation under all changes of load. The temperature rise after a full load run of ten hours will not exceed 40 deg. The bearings, which are ring oiling, are built upon the ball and socket principle. The armature is of the barrel wound type. The cast iron flange, bolted to the armature spider at each end of the core, forms a support as well as a cylindrical receptacle for the projecting ends of the coils. The flange extension also protects the windings from any oil that may be thrown from the bearings. The surface of the interior of the armature is perfectly smooth, offering no opportunity for the collection of oil or dust. Ventilation is effected by the use of specially constructed vanes, forming air ducts between the laminæ of the core. These convert the armature into a blower, and create a strong draft through the windings. In the building up of the commutator, drop forged segments of pure lake copper are used. These are thoroughly insulated with the best amber mica, thereby avoiding all trouble in the way of "High mica" due to the use of a hard quality. Being supported upon cast-iron spiders the radiating surface of the commutator is very large, with the result that it runs exceptionally cool and that heating is reduced to the minimum. Carbon brushes are used exclusively and are mounted in holders of the sliding socket type, having every facility for ready adjustment. All machines are thoroughly tested before shipment by being given a full load run during a continuous period of six to eight hours.



STURTEVANT NEW DIRECT CONNECTED SHIP LIGHTING SETS.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Dissolution of Co-Partnership.

New York, March 30, 1901.

Notice is hereby given that the co-partnership heretofore existing between the undersigned, under the firm name of Aldrich & Donaldson, proprietors and publishers of "Marine Engineering," New York, has this day been dissolved by mutual consent.

H. L. ALDRICH.
H. F. DONALDSON.

New York, March 30, 1901.

I have this day transferred my entire interest in the firm of Aldrich & Donaldson to my partner, Mr. H. L. Aldrich, and with this issue cease to exercise the editorial control and management of MARINE ENGINEERING. *In withdrawing from the publication with which I have been associated as editor for the four years of its existence to date, I desire to express my acknowledgments of the co-operation of those shipbuilders, shipowners, naval architects, and marine engineers who have given data, drawings and other material for publication with great liberality, and also my indebtedness to our contributors, the value of whose writings has materially aided in securing for* MARINE ENGINEERING *its standing in the field of technical journalism. For the new management I bespeak a continuance of the cordial relations which have ever existed between the editor and supporters of this publication, and wish for all concerned the greatest measure of success.*

H. F. DONALDSON.

New York, March 30, 1901.

There will be no change in the policy of MARINE ENGINEERING *because of the retirement of Mr. H. F. Donaldson. As general manager of the new publishing company, I assure our friends that we shall continue to break each year's record in the quality and value of the magazine.* *H. L. ALDRICH.*

AT a special meeting of the Council of the Society of Naval Architects and Marine Engineers, held in New York last month, Naval Constructor Washington L. Capps was elected to the office of secretary-treasurer to fill the vacancy caused by the resignation of Rear Admiral Francis T. Bowles, U. S. N. Admiral Bowles handed in his resignation upon his appointment as Chief of the Bureau of Construction and Repair, but will still continue to act as member of the Council and of the Executive Committee. Naval Constructor Capps is familiar with the duties of his new office, having occupied it for a considerable time after the organization of the Society in 1893. The Society will without doubt, at the proper time, express to Admiral Bowles the appreciation of his services which the members entertain. When it is recalled that the office has been an honorary one, the nature of those services will be better appreciated. Few persons who have not undertaken such work realize what demands are made upon the time, skill and patience of the secretary. To interest members sufficiently to undertake the preparaton of papers, and to get such papers, with all their wealth of illustration, into form for reading, is of itself a very difficult and tedious task. When to this is added the managerial work necessary to the holding of meetings, the publication of the proceedings, and the multitudinous and multifarious office duties of secretaryship and treasurership, the only wonder is that the executive officer of the Society has any time left for the practice of his profession. It must be a source of gratification to the retiring secretary to recall the unlimited confidence placed in his ability and judgment by the officers and members of the Society during his long term of office, and an equal cause of gratification to the officers and members to review the work of his stewardship. The professional abilities and personality of his successor, Naval Constructor Washington L. Capps, are a guarantee that the work will be continued in an equally efficient manner. We are of the opinion, however, that this is a fit time to consider the question of some more sub-

stantial recognition of the work of the office than "the customary vote of thanks" at the annual meeting.

ANOTHER horror was added to the list of losses of ocean passenger vessels last month, when the Pacific Mail S.S. *City of Rio de Janeiro* went down in San Francisco Bay and more than six score persons were drowned. On other pages we have published a full report of the investigation into the causes of this disaster, which placed a share of responsibility on some of the survivors but did not fully clear up the mystery of the loss. It has not yet been authoritatively stated why the vessel was brought into the position where such a loss was possible, and why the vessel sank so quickly after she struck. The first could probably be determined by an examination of witnesses, the second it would be impossible to determine without a physical examination of the vessel, which now lies at the bottom in deep water. From the testimony given at the investigation, made by the U. S. Steamboat Inspectors, it is to be inferred that when the captain decided to bring the ship in, there was not steam enough on the boilers to handle her properly. Were this the case the signals transmitted from the bridge could not be properly responded to below, and the pilot, not knowing the real conditions at the time, would assume that the vessel would behave normally. Miscalculations might easily result that would in the conditions of tide, bring the ship to destruction. The chief engineer admitted that of his own knowledge he did not know what the conditions were below when orders came to get under way, but delegated his authority to a subordinate. The U. S. Inspectors apparently hold Chief Engineer Herlihy partly to blame for the disaster, for they have found that he is unfit to occupy such a responsible position and have revoked his license. The indifference of this engineer seems to have not been confined to his own duties, but to the safety of the members of his staff also. He apparently did not order his assistants on deck, and they, in faithful performance of their duty, remained below and so had no chance to escape. The U. S. Inspectors have also censured Captain Ward for having left a safe anchorage to come into port in a fog, and Pilot Jordon is blamed for having attempted to bring the ship in under the circumstances. The responsibility for the disaster is therefore laid at the door of the owners, and the results of this investigation would probably make very convincing evidence in any action for damages that might be brought against the company. The rapidity with which the vessel sank after striking would indicate that she must have sustained severe structural injury. The *City of Rio de Janeiro* was a comparatively old vessel, built at a time when the question of subdivision by bulkheads was not as well understood as now. Though she was divided into compartments, it may have been that the contact with the reef was at a point where a bulkhead joined the hull, so that two compartments were simultaneously flooded, or the pressure of water in the damaged compartment may have broken down the bulkheads at both ends. Whatever the reason, the vessel went down so rapidly that she carried the greater number of the boats down with her, hanging on the davits. Once again was emphasized the utter inadequacy of present methods of saving life in case of total loss of the vessel. The problem is at once the most serious and most difficult of any that now confronts the naval architect and ship owner. While its solution is being worked out, the safety of the individual should be more carefully considered. Every passenger on an ocean steamer should be provided with a life belt and instructed in its use. This could be done by the stewards when the passengers are assigned to their rooms after going on board. Had each person on the ship put on a life belt when the vessel struck, it is probable that scores would have been saved, as there were a number of fishing boats in the vicinity that helped to rescue the survivors.

A REPORT has been made by the Committee appointed by the British Admiralty to inquire into the question of water tube boilers in the British Navy. This Committee, it will be recalled, was composed of naval officers, engineers of the mercantile marine, and scientists. The cause of the inquiry was the result of adverse criticisms of the Belleville type of boiler, with which a number of the newer British ships are fitted. The Committee has reported adversely of the Belleville boiler, recommending that it be not fitted to ships in future, except those for which boilers are already complete, but it does not suggest the removal of any boiler of this type from vessels already completed.

EDUCATIONAL DEPARTMENT.

EMERGENCY REPAIRS OF ELECTRICAL MACHINERY ON BOARD SHIP.—II.

BY WM. BAXTER, JR.

Short Circuits in Armatures.

Short circuits in armatures are produced by the destruction of the insulation at points where it is weak. They may be divided into two classes; those in which the insulation between the wires is destroyed and those in which the defect occurs in the insulation separating the wire from the iron core. With the latter type of defect the machine is almost sure to be rendered useless at once unless it is well insulated from the ground, for the chances are that there will be some point in the external circuit at which the insulation is not very strong, and if such is the case, as soon as the defect develops in the armature the weak external point will give away and thus establish a short circuit between the defective point in the armature and the one in the external circuit. On this account it is always desirable to mount generators so that the machine as a whole is perfectly insulated from the ground. In a wooden vessel this result is accomplished without any special effort,

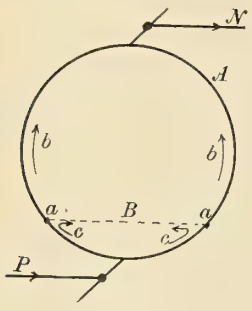


FIG. 6.

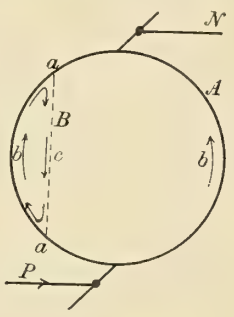


FIG. 7.

for the ship itself is a sufficiently perfect insulator at all points, but in iron ships such may not be the case, as, for example, where the generator is secured to an iron floor. In all such cases a wooden foundation should be provided and the holding down bolts should be properly insulated from the floor and the supporting beams.

When a generator armature becomes short circuited it continues to develop a current more or less reduced in strength, but, generally, in the course of a few seconds the fact that the armature is injured becomes known because the short circuited coils, or a portion of them, get so overheated as to burn the insulation, filling the room with smoke and the odor of burning shellac. Frequently the effect of the short circuit is so disastrous as to completely stop the generation of current.

The way in which a short circuit accomplishes its work in a two pole armature can be readily explained in connection with Figs. 6 and 7. In both of these figures the circle *A* represents the armature wire drawn out into a large loop, the brushes being set to bear upon it at the points where the current would enter when the armature is in operation. If at the points *a a* the insulation becomes imperfect, a short circuit can be formed between them as is indicated by the line *B*. If the armature is of the ring type there is only one way in which such a connection can be formed, and that is by the coming into contact of the bare wire at the two points with the iron core. In a drum armature the contact can be between the two wires without the assistance of the iron core. In a drum armature all the coils cross each other at the ends of the core, therefore, it is perfectly possible for points in the winding that are far apart to come into contact if the pressure of the wire above them is sufficient to press the insulation out of the way. In a ring armature the coils are side by side, so that a direct short circuit from coil to coil in such an armature can only occur between the adjoining coils. From this we see at once that the danger of short circuits in ring armatures is far less than in those with a drum winding, and that when such defects do occur we must look for the trouble at the points where the wire is most likely to come in contact with the armature core or with some metallic part that is in a position to connect with all the coils. For example, the bands that hold the wire in place can make contact with the bare wire of all the coils, as they press directly upon them.

The damage done by a short circuit depends upon the distance between the connected points *a a*, and also upon the nature of the contact. Why this is the case will be understood from the nature of the action which takes place. Suppose the short circuited points are in the position shown in Fig. 6, then it is evident that if the current generated by the armature flows in the direction of the arows *b b*, that no current will flow through *B*, for the tendency of the current to flow from right to left would be just as great as the tendency for it to flow from left to right, as is indicated by the arrows *c c*, and as these would meet head on there would be no current. Suppose, now, that the armature has revolved through one-quarter of a revolution so as to bring the short circuited points into the position shown in Fig. 7. In this position we can see that a strong current would flow through *B*, for the current generated in the armature coils between the points *a a* would find an easier path through *B* (which has practically no resistance) than through the remainder of the armature and in addition the external circuit. As a result nearly all the current generated in the short circuited coils would flow through *B* in the direction of arrow *c*. If the short circuited points were on opposite sides of the diameter they would come directly under the brushes in Fig. 7. In that case the current flowing through *B* would not only be that developed in the coils on the left side of the armature, but also that developed in the coils on the right; that is, it would be practically all the armature current, so that in this position little or no current would pass to the external circuit. Now if when the points *a a* divide the armature wire into two equal parts, the current through *B* in the position of Fig. 7 is practically all the current, then it follows that if the points *a a* are nearly diametrically opposite, both parts of the armature wire will still furnish their share of the current that flows through *B*. Even with the short circuited points *a a* in the position shown in Fig. 7, some of the current through *B* will come from the coils on the right side, although the greater part will come from those on the left.

If the contact at the points *a a* is a perfect one the short circuit will not be discovered until the heat developed by the current passing through *B* is sufficient to burn the insulation of the wire. If the contact at *a a* is not perfect the high resistance offered thereby will result in the development of a sufficient amount of heat at these points to melt the wire and thus break the short circuit by producing a break in the continuity of the armature wire. Most short circuits are of the latter kind.

In any kind of short circuit the action is so rapid that it is only the work of a few seconds to produce a burn out of one type or another. If the contact at the points *a a* is perfect or nearly so, then all the coils on the armature will be heated, and those through which the path from *a* to *a* is the shortest, will be heated the most. This fact enables us to locate the short circuited points, for we know that they are at the ends of the coils that are injured the most. Unless the short circuit divides the armature coils very nearly into two equal parts, the strength of the current that will flow through the short part will be so much greater than that in the balance of the coils, that this part of the wire will be burned out before the other is seriously injured. Thus it will be seen that except in extreme cases only a portion of the armature coils will be damaged by a short circuit.

In the majority of cases the contact at the points *a a* will be imperfect, and on that account the heat generated by the current passing through them will be sufficient to soon raise the temperature enough to fuse the wire and thus open the circuit. Such a burn out will destroy only one or two coils so that the damage can be repaired by cutting them out of the circuit in precisely the same way as if they contained broken wires, the course of proceedure for which was explained in the previous article. In ring armatures the points *a a* will be as far apart as the coils that are short circuited, and in every case at least one of them can be found. It may not be possible to detect the other from the appearance upon the surface of the armature, for the heat generated at the two points will not be equal, hence, one will burn out before the other one becomes hot enough to show its position. In doctoring up such a case all we can do is to cut out the defective coil we have found and then start up the generator and watch it carefully to see whether the other weak point makes its appearance. In most instances it will not, for the first coil cut out will break the circuit for the second defect, and thus prevent the passage of current through it. If, however, the second point shows up after the trial run, we cut it out in the same way as the first one, and then we can be reasonably sure that the machine will run until port is reached.

In a drum armature the points *a a* will be as far apart as the coils if they form a short circuit through the binding bands, and may be equally distant if they connect with the iron core, although not necessarily so, for one coil may come in contact with the iron on the outer surface of the core, while the other may touch at some point on one of the ends. If, therefore, on inspection we find that one of the points *a* connects with the core at any point, we know that the other defect connects at some other place. If the points *a a* are on the wire itself, then they will be together, and when we find one we find both. As a rule in such cases the insulation of all the wires in the vicinity of the burn out will be damaged, so that it is advisable to disconnect from the commutator all the ends of the coils that pass near this spot, and test them to ascertain whether the several coils are clear from each other. If any are found to be in contact we can pry up the wires around the burn out with a hard wood wedge, and after a while will find where the contacts are. These we can separate with insulating material, and when all the ends of the coils that pass near the damaged part are found to be insulated from the ends of other coils, they can be reconnected with the commutator, in the same order as they were before. If the connection between any two coils cannot be found, then one of these coils will have

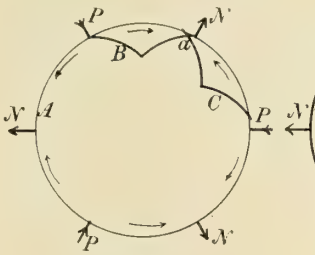


FIG. 8.

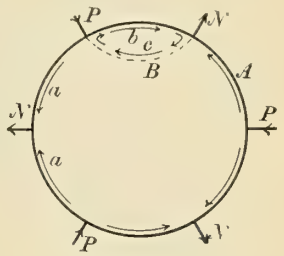


FIG. 9.

to be left disconnected, that is, we will have to cut it out, just as if it had a broken wire.

The effect of short circuits in multipolar armatures can be understood from Figs. 8 to 11. In the first of these figures the circle *A* represents the armature, and *C D* are two coils which cross each other at *a*. At this point it is possible for the insulation to become defective and thus form a short circuit. For a six pole armature a short circuit between coils in this position would be the most destructive of all that could occur, for the total voltage of the machine would act to drive a current through the defective points. This, however, would be the case only when the coils are connected into a lap winding. With a wave winding the strongest

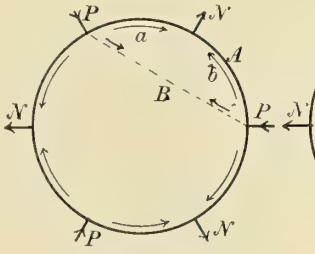


FIG. 10.

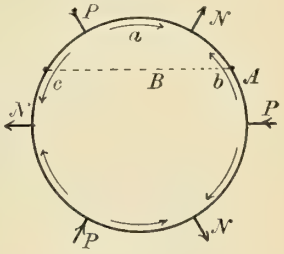


FIG. 11.

current through the short circuit would be obtained with the short circuiting points diametrically opposite.

A short circuit as shown in Fig. 8, at *a*, is the most likely to occur in a multipolar armature, for it can be produced by the destruction of the insulation separating two coils at the crossing points. Short circuits between coils further apart cannot be formed except through contracts with the core or some other metallic part of the armature, such as the bands, or the arms of the supporting spider. Fig. 9 shows the path of the short circuit represented in Fig. 8. In Fig. 9 the circle *A* represents the armature coils drawn out into a loop the

same as in Fig. 6, and the line *B* is the short circuiting connection. As will be noticed, the points connected by *B* are as far apart as the brushes *P N*, hence, for the multipolar armature this short circuit is the same as one for a two pole armature which divided the coils into two equal parts.

In a multipolar armature it is possible to have short circuits that will do no damage, although such a condition cannot very well be obtained practically. Figs. 10 and 11 illustrate a short circuit which in a six pole armature would be harmless. In the first figure it will be seen that the connecting line *B* runs from one *P* brush to another of the same sign. It will also be noticed that the currents flowing from these brushes toward the center brush *N*, and which are indicated by arrows *a b*, are equal, hence, neither one could impel a current through *B*, for in this path they would act in opposite directions and with equal force. The currents flowing into the armature through the two *P* brushes could not pass through *B*, for, as shown by the arrows above this line, they would be in opposition to each other. Thus it will be seen that with the short circuited points under the two *P* brushes, no current could flow through the short circuit *B*. Fig. 11 shows the armature after it has rotated far enough to bring the short circuiting points midway between the brushes. As can be seen from this figure, an effort made by the current flowing from brush *P* to brush *N*, that is, current *a* to flow through the short circuit *B*, would be opposed by one-half the strength of current *c* and one-half the strength of current *b*, and these two halves are just equal to the whole of current *a*, hence, in this position no current could flow through *B*. In the same way it can be shown that there is no position of the armature in which a current can flow through a short circuit between points as far apart as any of the brushes of the same sign. In practice this condition cannot be fully realized simply because we cannot make a machine that is so perfectly balanced in all its parts as to make the currents generated in the several sections of the armature exactly equal. Therefore a small current would flow through a short circuit between points spaced as far apart as the similar brushes, but it would be a weak current. This fact assists us in finding the points where a multipolar armature is short circuited, for if the defect is serious, showing that it was produced by a strong current, we know that the connected points must be about as far apart as the adjoining brushes, probably a little more or a little less, but they cannot be found as far apart as the brushes of the same sign. On the other hand, if the damage indicates that it was produced by a weak current, we will expect to find the defects at a distance from each other nearer equal to the distance between similar brushes.

To doctor up a multipolar armature damaged by a short circuit we cut out the defective coils just as in the two pole armature.

Revenue Cutter Service.—At the last Congress the bill to reorganize the U. S. Revenue Cutter Service failed to pass. It will probably be brought up again in the next Congress. Several very necessary reforms are incorporated in the bill, and its passage would remove many unjust conditions from which the service now suffers.

QUERIES AND ANSWERS.

Q.—Please inform me if I should change the propeller on a steam yacht for one that is 7 in. larger and of the same pitch? Will I get more speed, or would it be better to use a wheel of the same diameter and greater pitch? The yacht is 142 ft. over all, 115 ft. water line, 18 ft. beam and 8 1-2 ft. draft. The engines are triple expansion, with cylinders 9 3-8 in., 16 in., and 25 in. dia., by 16 in. stroke, and turn 200 rev. per min. With the propeller that is on now she will make 13 knots. The propeller is manganese bronze with 3 blades. Particulars are: Dia. 6 ft. 3 in., hub 18 in., pitch 7 ft. 6 in., thickness of blades at root 2 1-8 in., helicoidal area 13.25 sq. ft. Would a larger wheel slow down the engines so that I would lose instead of gaining speed? O. D.

A.—It is impossible to advise regarding questions of this character without a more detailed knowledge of all the conditions and circumstances of the case. Without more complete information it is impossible to know the displacement of the yacht, and as the steam pressure is not given the I. H. P. cannot be found or even safely guessed at. Advice regarding the changing of a propeller requires careful study and as complete a knowledge as possible of the facts of the case. In general you cannot expect to obtain more speed without more power Merely changing a propeller will not of itself give you more speed unless the one previously in use was very inefficient. The increase of diameter without other change would probably decrease the revolutions, and the slip and give you about the same speed for the same power; but as to whether or not this is desirable or what may be desirable cannot be determined from the data which you give.

Q.—What is the horsepower of a high pressure engine 10 1-2 in. by 16 in., 200 lb. steam, 240 revolutions, steam cuts off after piston travels 5 in. of stroke? P.

A.—With cut-off at 5 in. on a stroke of 16 in. making due allowance for a clearance of abont 6 per cent, we should have about 2.83 expansions. Using the same formula for mean pressure as in (5), we have for the logarithm of 2.83 the value 1.04. Substituting and reducing we find for the mean forward pressure,

$$p = 215 \times 204 \div 2.83 = 155.$$

Considering this as a non-condensing engine, we shall have a back pressure of about 18 lb. Subtracting this we have 137 as the mean pressure from an ideal card. We may expect to actually realize about .85 of this, or 116 lb. say. Then substituting in the H. P. formula we have:

$$H = 2 \times 116 \times 1.33 \times 86.6 \times 240 \div 33000$$
$$\text{or } H = 194\ 3.$$

Q.—To settle an argument will you please decide. A says that it takes 5 lb. of pressure to lift water 1 ft., while B says that it takes only 2 lb. Which is correct? A. H. W.

A.—The pressure per square inch required to lift water one foot will be equal to the weight of a column of water one square inch on the base and one foot high. This will be 1-144th of a cu. ft., and its weight will be therefore 62.5 ÷ 144 lb. = .434 lb., or a little less than one-half pound. More strictly this is the pressure which would just balance one foot of water. In order to lift water as in a pump and deliver it with some velocity of flow, an increase in the above pressure must be made in order to overcome friction, inertia of valves, etc.

Q.—Which of the two, lignum-vitæ or babbitt, is considered the most efficient when used for the lining of stern bearings for fast steam yachts? J. H. J.

A.—There is probably nothing better as a lining for stern bearings than the standard type of lignum-vitæ fitting. It is, however, somewhat more expensive and difficult to fit than babbitt metal, and for this reason the latter is often preferred, especially in small craft. In clear water babbitt will run well and give good satisfaction with very slow wear; but in water containing sand or grit it is liable to cut out quite rapidly.

ENGINEERS' DICTIONARY.—XXXIV.

Piston Ring.—See under PISTON.

Piston Rod.—The rod which carries the piston and connects it to the other moving parts of the engine.

In the usual form of marine engine it connects the piston with the cross head and may be of two forms,

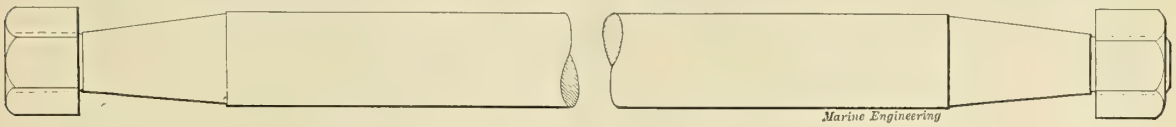


FIG. 96.

as shown in Figs. 96, 97, according to the type of cross-head. The method of securing the rod at the ends is sufficiently shown by the figures. In modern practice

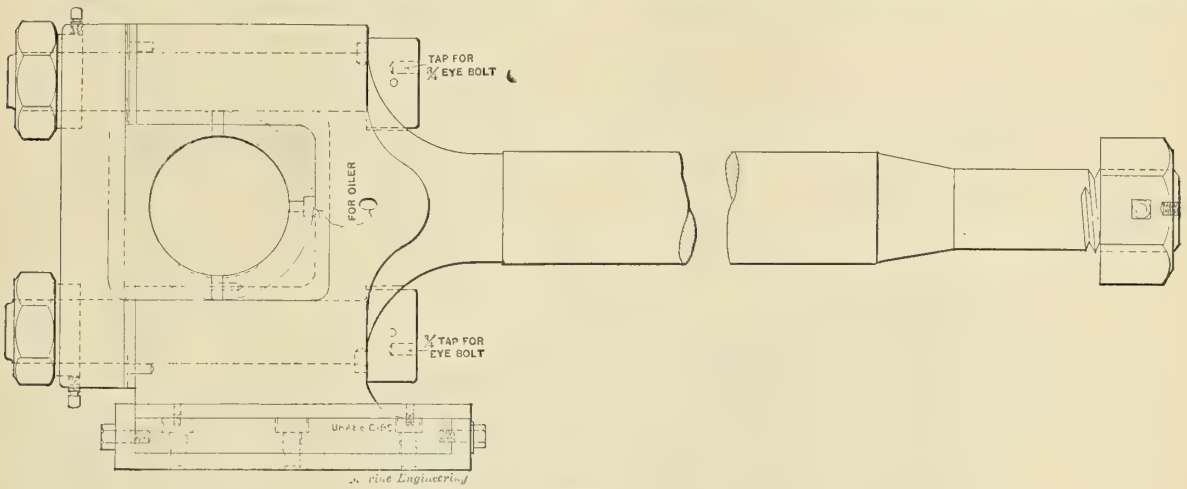


FIG. 97

piston rods are made of steel and are frequently hollow, to secure greater lightness for the same strength, as well as to insure the removal of any flaws in the material, such being more likely to occur near the center of the rod.

Piston Spring.—See under PISTON.

I. N. A.—The Summer 1901 meeting of the Institution of Naval Architects is to be held in Glasgow. The Council has accepted an invitation from the Lord Provost and Corporation of Glasgow to hold the summer meeting in that city on June 25 and the three following days. An especially interesting feature of the meeting will be the probable visits to the International Exposition at Glasgow in which a very extensive marine exhibit will be on view.

SCH. REBECCA PALMER.—The five masted schooner, *Rebecca Palmer*, was launched from the yard of Cobb, Butler & Co., Rockland, Me. She was built at a cost of about $100,000 and is of these dimensions: Length of keel, 251 ft.; length over all, 285 ft.; beam, 46.1 ft.; depth of hold, 23.1 ft. The *Palmer* is the largest schooner ever built at a Rockland yard. William F. Palmer, of Boston, is managing owner.

IT IS announced that the Holland-American line will put three new vessels in the freight route between Newport News and Rotterdam.

NOTE ON THE PERFORMANCE OF AN OCEAN FREIGHT AND CATTLE STEAMER.

BY F. D. HERBERT.

During the summer the writer had occasion to cross the ocean on one of the older type of freight and cattle steamers built in 1891 in a Scotch yard. The progress in shipbuilding has been so great in recent years that this class of steamer is fast being replaced by the modern intermediate type, yet it is interesting to note the excellent performance of this ship built ten years ago.

The data of size and form is given in the accompanying tables. About 320 head of cattle are carried on the main deck and in pens built on the spar deck. There are six cargo hatches.

The propelling machinery consists of one triple expansion engine with cylinders 30 1-2 in., 48 in., 79 in. dia. by 60 in. stroke. The arrangement of cylinders and sequence of cranks at 120 deg. is, looking aft, intermediate, high, low. A piston valve is fitted on the high pressure cylinder and slide valves on the intermediate and low pressure cylinders. Five cast iron and two wrought iron columns support the cylinders, the latter two at the front, under the high pressure cylinder. On these two wrought iron columns are placed the operating levers and gauges. This arrangement gives an open and light appearance to the engine and permits of ready access to the working parts. The air pump is direct connected to the low pressure cross head. The exhaust from the low pressure cylinder leads through the high pressure rear column to the condenser. The low pressure rear column serves as the hot well and on it is bolted the main feed pump. A single vertical engine drives the centrifugal circulating pump. The steam steering engine (located in the engine room), dynamo and all other auxiliary machinery

are supplied with steam through a reducing valve at 70 lb., from 183 lb. boiler pressure. An evaporator and distiller are carried.

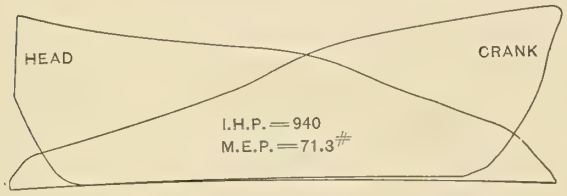
There are wing coal bunkers in the engine room above the starting platform and 'thwartship bunkers forward and aft of the boiler compartment. In the forward stoke hole the large donkey boiler is set in a recess in the coal bunker. This boiler is of ample size to supply steam for all uses when the ship is in port. The total bunker capacity is 1,000 tons.

The trial data is taken from averages of over a 3,000 mile run, and includes running with but two boilers for sixteen hours, the time required to first repair and then replace a leaky boiler tube.

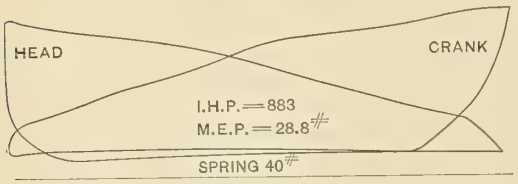
The weather was good throughout.

The accompanying set of cards indicate the maximum power developed.

The small apparent slip of 2 per cent, when corrected for the wake factor according to Prof. Mc-



SPRING 80#



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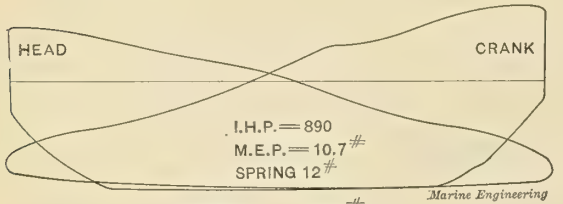

Marine Engineering

STEAM ____ 188#
RECEIVER ____ 68#
VACUUM ____ 26#
REVOLUTIONS ____ 56

TRIAL DATA.

I. H. P. main engine	2,600
Revolutions per minute	53.7
Steam pressure, lb	183
1st Receiver, lb	67.5
Vacuum, inches	24
Speed, knots	11.4
Slip	2 per cent
I. H. P. per 100 sq. ft. wetted surface at 10 knots	4.87
Admiralty coefficient	278
Coal burned per hour, lb	4,390
Coal per I. H. P. main engine, per hour	1.68
Coal per sq. ft. grate, per hour	17.1
Coal per ton displacement, per mile	0.035

Dermott's rule, gives an estimated true slip of 21 per cent, which is the calculated amount for greatest efficiency for this form of propeller.

CONSTRUCTION DATA.

Gross tons	5,158
Net tons	3,340
Length between perps	435 ft. 0 in.
Beam, moulded	46 ft. 0 in.
Depth, main deck	27 ft. 11 in.
Depth, spar deck	35 ft. 9 in.
Draft	27 ft. 10 in.
Displacement	11,000
Tons per inch at 27 ft. draft	39 4
Area midship section at 27 ft. 10 in., sq. ft.	1,216
Wetted surface at 27 ft. 10 in., sq. ft.	36,050
Block coefficient	69.2 per cent
Midship section coefficient	95.1 per cent
Dead weight carrying capacity, at 27 ft. 10 in.	7,000
Fresh water, tons	742
Coal	1,000
Engine; one 30 1-2 in , 48 in., 79 in. by 60 in. stroke.	
Boilers; three double ended Scotch type, 13 ft. 7 in. dia., 17 ft. 6 in. long.	
Furnaces; two in each end of each boiler, 48 in. dia., grate 6 ft. 0 in. long.	
Total heating surface, sq. ft.	9,470
Total grate surface, sq. ft.	257
Ratio H. S. to G. S.	36.9
Donkey boiler, 11 ft. 6 in. dia by 9 ft. 6 in. long; two 40 in furnaces.	
Propeller diameter	21 ft. 0 in.
Propeller pitch	22 ft. 0 in.
Pitch ratio	1 05
Area propeller, sq. ft.	108
Area prop.—area disk	0.31

STEAM TURBINES.—A very comprehensive paper on "Steam Turbines," read by Francis Hodgkinson before the Engineers' Society of Western Pennsylvania has been published in pamphlet form by the Westinghouse Machine Company of Pittsburg, Pa. The writer takes up his subject historically and brings the reader to the most modern form of Parson's turbine. The pamphlet is well illustrated and is a very useful addition to the literature on the subject, as it brings into a small compass a great deal of information, some of which has not before appeared in print. Brief mention is made of the turbine-driven torpedo boats constructed in England, and with which our readers are already familiar. We believe that the pamphlet has been printed for distribution to those who are interested in this subject. The author was identified with the development of the steam turbine in England and since 1896 has been in the employ of the Westinghouse Machine Company.

S.S. NEW YORK.—A mishap occurred on the American liner *New York* on her last westward trip which ended in New York on March 17. While on the voyage over, a break occurred in the refrigerating plant in the after part of the ship and caused the escape of fumes of ammonia into the compartments occupied by steerage passengers and a number of stewards. A number of persons were prostrated and two deaths subsequently occurred. Following this, on March 15, the port tail shaft broke without, however, causing much serious damage. Hawsers were put around the propeller blades, and in this way it was prevented from being lost together with the fractured end of the shaft. The vessel proceeded under one engine and arrived in port without further mishap.

Both Mexico and the Netherlands are considering additions to their navies.